Research Note 80-28

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AD A107530

APPLICATION OF TACTICAL DATA SYSTEMS FOR TRAINING VOL. IV - DEVELOPMENT OF COURSEWARE AND ANALYSIS OF RESULTS FOR GED MATH

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SYSTEMS MANNING TECHNICAL AREA

U. S. Army
Research Institute for the Behavioral and Social Sciences

January 1974

U. S. ARMY RESEARCH INSTITUTE FOR THE BEHAVIORAL AND SOCIAL SCIENCES

A Field Operating Agency under the Jurisdiction of the Deputy Chief of Staff for Personnel

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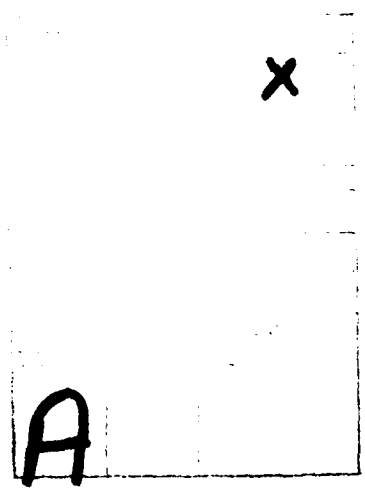

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NOTICES

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER Research Note 80-28	2. GOVT ACCESSION NO. AD-A107 530	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) APPLICATION OF TACTICAL DATA SYSTEMS FOR TRAINING VOL. IV - DEVELOPMENT OF COURSEWARE AND ANALYSIS OF RESULTS FOR GED MATH		5. TYPE OF REPORT & PERIOD COVERED 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) W. G. Hoyt, A. K. Butler and F. D. Bennik		8. CONTRACT OR GRANT NUMBER(s) DAHC19-73-C-0029
9. PERFORMING ORGANIZATION NAME AND ADDRESS System Development Corporation 2500 Colorado Avenue Santa Monica, CA 90406		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS US Army Research Institute for the Behavioral and Social Sciences, 5001 Eisenhower Avenue, Alexandria, VA 22333		12. REPORT DATE January 1974 13. NUMBER OF PAGES
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) Unclassified 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Tactical ADP systems
Automated Instruction (AI) (CAI)
MOS training (11B40)

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This research report demonstrates that a complex Computer-Assisted Instruction (CAI) system can be integrated within a tactical computer system and that learning does take place within the tactical computer environment.

While it is unreasonable to expect that a given method of instruction will be applicable to all Army personnel, it should at least cover a fairly broad range of personnel with varying aptitude (G) scores. These personnel

Item 20 (Cont'd)

present problems in regard to training costs. While student costs (time) is a consideration, instructor time (cost of preparation and instructing) is a more heavily weighted factor. A training program which has the capability to reduce instructor time in relation to student time offers a cost-effective, cost-saving approach to training.

APPLICATION OF TACTICAL DATA SYSTEMS FOR TRAINING

FINAL REPORT

VOLUME IV - DEVELOPMENT OF COURSEWARE AND ANALYSIS OF RESULTS FOR GED MATH

2 JAN 1974

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TM-5261/003/00

FOREWORD

System Development Corporation submits this Final Report in conformance to Contract No. DAHC19-73-C-0029, Application of Tactical Data Systems for Training. It is structured as follows:

Volume No.	Title	*SDC ID No.*
I	Executive Summary	TM-5261/000/00
II	AI/DEVTOS Automation Studies	TM-5261/001/00
III	Development of Courseware and Analysis of Results for MOS 11B40	TM-5261/002/00
IV	Development of Courseware and Analysis of Results of GED Math	TM-5261/003/00

While each document noted above is a discrete entity, references have been made to other volumes when such would provide amplification of--or information supplemental to--the topic under discussion. Computer listings of the statistical results of this study are presented under separate covers as Attachment to appropriate volumes.

ACKNOWLEDGEMENTS

ARI wishes to acknowledge the efforts made by US Army military and civilian personnel in the development of the course materials and conduct of MASSTER Test 122, IBCS: Automated Instruction. Our sincere thanks to the members of the US Army Research Institute for the Behavioral and Social Sciences, particularly to Mr. James Baker, Dr. Michael Strub, Mr. Cecil Johnson, Mr. Sidney Sachs, and Dr. Charles Nystrom (Fort Hood Field Unit); and to Major John Mackey and Major M. Buzz Hensel, Tactical System Development Group (TSDG), CSC, Fort Hood, Texas.

The cooperation of personnel of the United States Armed Forces Institute, Madison, Wisconsin, particularly Dr. Clay Brittain, aided greatly in developing the training objectives for the GED course materials. While it is not possible to specify each by name in this context, their willingness and capability in contributing to this effort have not gone unnoticed.

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GENERAL EDUCATIONAL DEVELOPMENT AI, S AND C GROUPS, VARIABLES 1-26:

ATTACHMENT A: Frequency Distributions

ATTACHMENT B: Means, Standard Deviations, Range of Scores, Intercorrelation Matrix

ATTACHMENT C: Individual Scores

GENERAL EDUCATIONAL DEVELOPMENT AI, S AND C GROUPS, VARIABLES 1-122:

ATTACHMENT D: Frequency Distributions

ATTACHMENT E: Means, Standard Deviations, Range of Scores, Intercorrelation Matrix

ATTACHMENT F: Individual Scores

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Section 1: INTRODUCTION

A. PROJECT BACKGROUND

The Army's current efforts to improve its overall training program, spearheaded by the work of the Board for Dynamic Training at Fort Benning, Georgia, has identified that future training will be increasingly decentralized, placing greater responsibility on unit and individual training programs. It is conceivable that tactical ADP systems could be made available to tactical units to alleviate the problems each will face in meeting its increasing unit training requirements by providing an Automated Instruction (AI) capability to supplement training resources. Data are needed that would delineate the potential payoffs as well as the pitfalls inherent in taking the techniques and materials of AI from the formal school setting to the field, and attempting to implement them using tactical ADP equipment to meet user training requirements in a tactical unit environment. Such information would provide an empirical basis for making broad management decisions regarding the Army's training needs of the future and should impact on Army tactical ADP system design by specifying "subsystem training packages" which these systems should accommodate.

In November 1971, ACSFOR requested OCRD to initiate a research effort defining the potential roles of tactical computers in training. Subsequently, OCRD and the U.S. Army Research Institute for the Behavioral and Social Sciences (ARI) developed a plan which was coordinated with ACSFOR and the Board for Dynamic Training. The plan was accepted and MASSTER Test 122, entitled IBCS: Automated Instruction, was scheduled by ACSFOR.

MASSTER Test 122 provided for the development of two stand-alone Automated Instruction (AI) packages--one to assist MOS 11B40 personnel in preparing for MOS proficiency testing and one for General Educational Development (GED). These packages were to be prepared and programmed for use with the DEVTOS tactical system at Fort Hood, Texas.

The decision to use 11B40 personnel was based upon Board for Dynamic Training identification of the maintenance of proficiency by 11B40s, the Light Weapons Infantrymen, as a significant unit training problem. In addition, a CONARC task group report on computer assisted instruction identified the 11B40 MOS as a top contender for attention in the "nontechnical" skills area. Within the four 11B40 MOS subject areas, Tactics and Crew Served Weapons were prime candidates because they accounted for most of the proficiency test failures. The same reasoning applied to the selection of the Mathematics area for GED.

In December 1972, the System Development Corporation (SDC) was tasked by ARI to develop and field test the two AI packages.

B. PURPOSE OF THE STUDY

The purpose of the study undertaken by SDC was to evaluate the feasibility of using Army tactical data systems for automated instruction. Special attention was directed toward identifying problems of user acceptance, measuring participant improvement in performance, and defining the technical problems encountered.

C. STUDY OBJECTIVES

Specific study objectives included:

- Determine the feasibility of using tactical computers for instruction in MOS training, specifically 11B40.
- Determine the feasibility of using tactical computers for instruction in GED topics, specifically mathematics.
- Determine the feasibility of using tactical computers to identify proficiency area weaknesses and the resultant special remedial training needed.
- Identify factors influencing user acceptability of automated instruction.
- Provide input data for design decisions which will satisfy the stated material need for a TOS automated instruction capability.

Also defined were the following subobjectives:

- Determine the amount of learning derived from an AI course on the 11B40 subject matter area entitled "Crew Served Weapons."
- Compare the learning of "Crew Served Weapons" achieved via AI with that achieved by self-study (non-AI) methods.
- Determine the amount of learning derived from an AI course on the 11B40 subject matter area entitled "Tactics."
- Compare the learning of "Tactics" achieved via AI with that achieved by self-study (non-AI) methods.
- Determine the amount of learning derived from an AI course in GED mathematics.
- Compare the learning of math achieved via AI with that achieved by self-study (non-AI) methods.
- Determine if AI applies equally well to personnel with different ACB scores.
- Determine if slow learners attain the same proficiency level as fast learners.
- Determine if educational level is correlated with learning using AI.
- Determine user acceptance of AI by means of an in-depth interview with each user subsequent to his training.
- Compile in easily interpretable form the results of all analyses conducted in the course of satisfying the above subobjectives.

D. VALUE AND IMPORTANCE OF THIS STUDY

The Army has a growing computer capability, especially in the area of tactical computers. These computers are not expected to be used full time for their tactical mission. Concurrently, the findings of the Board for Dynamic Training indicate that Army Training needs to be improved. The ways that such improvement can take place are being examined very closely. One of these is automated instruction (computer-assisted instruction (CAI)).

This study demonstrates that:

- *A complex CAI system can be integrated within a tactical computer system.*
- *Learning does take place within the tactical computer environment.*

While it is unreasonable to expect that a given method of instruction (i.e., AI) will be applicable to all Army personnel, it should at least cover a fairly broad range of personnel with varying aptitude (GT) scores. An allied consideration is what happens to Army personnel in the lower range of GT scores. These personnel present problems in regard to training costs. While student costs (time) is a consideration, instructor time (cost of preparation and instructing) is a more heavily weighted factor. A training program which has the capability to reduce instructor time in relation to student time offers a cost-effective, cost-saving approach to training.

The statistical and practical results of this study indicate that:

- *Learning via AI occurs with Army personnel whose GT scores cover a broad range.*
- *Army personnel with relatively low GT scores can learn effectively without high instructor costs.*

One of the questions in regard to AI (and other methods of instruction) is the acceptability of the method. Data in regard to acceptability are important in making command decisions concerning methods of training. These data should come from Army personnel who have been exposed to this method of instruction in a subject area where training is needed.

Results of interviews conducted during this study reveal that:

- *The AI method of instruction is highly regarded by MOS 11B40 AI participants.*

In the past, typical Army classroom training has been characterized as follows:

- Geared to the slowest individuals in the class
- Few opportunities for individualized training
- Lacking the environment or opportunity for questions or clarification during the presentation
- Boring and uninteresting
- Not necessarily accurate
- Disjointed...little continuity
- Omission of the "why" of training, which leaves it up to the individual student to determine the importance of the training--an unnecessary and perhaps overwhelming burden which he (as well as some instructors) cannot handle.

This study identifies:

- *Ways in which AI alleviates these deficiencies.*
- *Factors in AI methodology that lead to increased participation, motivation and morale--i.e., factors that account for its effectiveness.*
- *Special considerations required by combat personnel for successful GED training.*

Although beyond the scope of this study, the Army is also faced with the unique problems encountered in training personnel with a limited grasp of English.

Results of this study indicate that:

- *An AI training program minimizes language problems by providing access to continued and/or repetitious instructional material.*

E. PURPOSE AND SCOPE OF THIS DOCUMENT

As defined in the FOREWORD, this document is one of four volumes of a Final Report submitted to the U.S. Army Research Office on the feasibility of the Application of Tactical Data Systems for Training. Information is presented in the following manner:

- Section 1 - provides a brief statement of the history and purpose of this study; defines study objectives; discusses the benefits to be derived; and outlines document structure.
- Section 2 - details the procedures involved in the design and development of courseware for the GED portion of the MOS 11B40 effort.
- Section 3 - describes the nature and conduct of the field test.
- Section 4 - documents and analyzes the results of the field test.
- Section 5 - states the conclusions drawn from this study and recommends additional areas for future applications of study findings as well as new areas for investigation.

Supplemental information is appended, as appropriate. In addition, computer listings of statistical results specific to the GED portion of this study are provided under separate cover as Attachments to this volume.

Section 2: DEVELOPMENT OF COURSEWARE

A. BACKGROUND

This section describes the process by which AI courseware for preparatory training in selected topics for high school equivalency mathematics was developed. The design and development of mathematics courseware commenced in January 1973 and was completed for transition to on-line checkout at Army Research Institute and field trials at Fort Hood beginning in August of the same year.

Five high school level batteries constitute the tests of General Educational Development (GED): English, social studies, natural sciences, literature, and mathematics. These tests measure attainment of some of the major objectives of the secondary school program of general education. Achievement in all of these areas correlates highly with basic skills in verbal and mathematical operations and reasoning, which are tapped by the English and mathematics batteries of the GED. For this project, the area specified for courseware development was GED mathematics. Of the two--English and mathematics, mathematics appears to be the more difficult, the more abstract, and the least amenable to daily practice in the military man's normal course of activities.

In addition, there are a number of reasons important to Army GED program managers for determining the utility of an AI mode of GED instruction. For many years both military and civilian personnel have earned high school and college credits upon successful completion of correspondence or extension courses conducted by USAFI, including GED preparatory courses. A recent USAFI study[1] indicates that the organized unit or basewide GED programs may be too inflexible or selective with respect to the target population.

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[1] Beusse, William E. Analysis of Survey Findings Concerning the USAFI High School GED Program. Draft report MR-73-3, Manpower Development Division, AFHRL, 1973.

The earlier in a man's military career that the GED test is taken and passed, the higher the paygrade at separation--yet those who take the tests early or as part of an organized base program are more likely to fail than are those who take the tests later and on their own initiative. Also, taking a preparatory course seems to aid low ability personnel in success on the GED, while such courses are taken less frequently and have little or no effect on whether higher ability personnel pass the GED. Therefore, there is a need to determine the extent to which automated instruction can enhance motivation to participate in preparatory courses, adjust to individual differences in self-confidence and ability to master GED material, provide more flexible options for participation than organized programs, and make learning more effective or efficient.

For the approximate one-half of military GED candidates who do take some type of preparatory course, four main types of courses are used: Army Preparatory Training (APT), group study courses, guided self-study (e.g., USAFI correspondence), and civilian high school GED courses. For this project, the amount of material to be developed for AI GED mathematics was to be equivalent to 12 hours of preparatory instruction: for example, to 12 hours of self-study using correspondence materials, or to 12 hours of group mode coursework. From the GED mathematics preparation areas of general mathematics, graphs and averages, algebra, and geometry, an initial selection was made to cover operations and applications in the decimals and percent areas of general mathematics, reading bar and line graphs, grouping and averaging data, and basic algebraic operations and expressions. After a review by USAFI, the selection of units for development in the AI mode was further constrained to approximately 12 hours of instruction in decimals, percent, graph reading, and computing an average, with supplementary work available for review and practice in whole number arithmetic. From the AI materials developed, the approximate 4-hour unit on decimals was selected for use in the field experiment.

GED AI development and MOS AI development (Volume III) proceeded in parallel and used the same basic development methodology. The procedures followed in developing AI courseware are well established; the specific steps are shown in Figure 2-1.

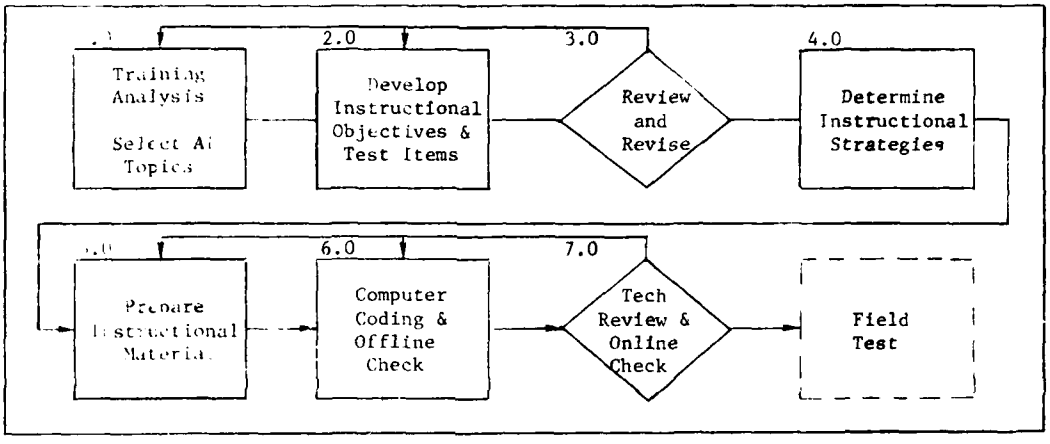


Figure 2-1. GED AI Courseware Developmental Process

As can be seen, a selection and analysis of what is to be taught leads directly to specifying learning objectives and the test items to assess mastery of the objectives. The process continues with planning the instructional content and the logic for sequencing the presentation of content according to contingencies which arise during learning and testing. Next, the CAI material is encoded, any supporting handouts prepared, and an editorial and technical critique and in-house checkout made of the material. This is followed by student tryouts, analysis of lesson deficiencies, revisions to content or logic, and presentation of completed instructional material to the target population in the AI field experiment (Section 3). Review and revision cycles are interspersed throughout the process, as shown in Figure 2-1.

Although the courseware developed for Crew Served Weapons and Tactics followed the same developmental steps and occurred in parallel with those for GED, they

are treated separately in this final report for convenience to readers. Developmental activities for these steps as they apply to the GED courseware development are described within this volume.

B. SELECTION OF SUBJECT MATTER AREAS

The initial task (Step 1.0 in Figure 2-1) was to identify subject areas within GED mathematics from which candidate units and topics would be selected for development into 12 hours of AI material. This was accomplished in several steps. In a preliminary analysis, GED reference materials were used by the project staff to compile a list of GED math subject areas and topics. The math subject areas were weighted according to approximate percent of coverage on a sample GED math test. Next, a set of criteria for AI topic inclusion-exclusion was formulated and applied to the subject matter list. This resulted in the preliminary selection of four math units: three from general mathematics--decimals, percent, graphs and averages--and a unit on algebra. Detailed training analysis information, learning objectives, and test items were developed for the four units. These were submitted as a working paper for review by GED math subject experts at USAFI Headquarters. From this meeting a list of subject matter topics and objectives was finalized for AI development.

1. Preliminary Analysis

In order to define a manageable subject area boundary and to determine the commonality and relative importance of math subject areas, SDC analyzed the content and structure of the following GED mathematics materials.

- GED Mathematics Test, Form J, June 1969.
- Brown, K. E., Snader, D. W., and Simon, L. General Mathematics, Book 1 (USAFI D151/D152). Laidlaw Brothers, Illinois, 1968.
- Brown, K. E., Snader, D. W., and Simon, L. General Mathematics, Book 1: Manual, Tests, Answers (USAFI D151.4/D152.4). Laidlaw Brothers, Illinois, 1968.
- Niederkorn, D. General Mathematics I, Study Guide (D151.14). USAFI, Madison, Wisconsin, 1968.

- Hockett, S. W. GED Math Home Study Guide. Barron's Educational Series, 1972.
- U.S. Dept. of Labor. AGEP High School Self-Study Program, November 1969. Booklets on: Solving Decimal Work Problems (PM 431-26), Solving Fraction Word Problems (PM 431-25), Solving Percentage Word Problems (PM 431-27), Tables and Graphs (PM 431-28), Line Graphs (PM 431-29), Algebra (PM 431-57), Powers and Roots (PM 431-58), Geometry (PM 431-59), Number Series (PM 431-60), Positive and Negative Numbers (PM 431-17), Student's Handbook (PM 431-SH), Teacher's Handbook (PM 431-TM).
- JCMP Revision Project. Tutor Program (Draft). How to Teach Students to Solve Math Story Problems (Unit M1). System Development Corporation, 1972.

Working lists of units, topics, and lessons were drafted using these references. Comparison of subject matter content and structure among these resource materials resulted in the composite list shown in Table 2-1. The sample GED math test (Form J, 1969) was used to obtain a gross index of relative emphasis of these subject areas on any GED math test, resulting in relative importance expressed as a percent of coverage in Table 2-1.

This first cut indicated that the overall inclusion priority, according to emphasis with respect to the GED test, should be: (1) topics in general mathematics, (2) topics in algebra, and (3) topics in plane geometry. Based upon this prioritization, the staff made the tentative decision that the AI modules would include selected topics from general mathematics and from algebra, with the emphasis given to general mathematics.

Next, selection criteria were formulated to aid in choosing specific GED topics for inclusion in (or exclusion from) the AI development. Strings of GED topics were analyzed to determine the extent to which they would permit a combination of the following:

TABLE 2-1. COMPOSITE LIST OF SUBJECT AREAS FOR GED MATH

SUBJECT AREA	TYPICAL GED WEIGHTINGS
I General Mathematics	50% - 62%
A. Whole numbers: Review/applications B. Fractions: Review/applications C. Decimals: Review/applications D. Percentages: Review/applications to finance, taxes, buying, wages E. Reading graphs: bar, line, circle F. Constructing graphs G. Computing averages: mean, median, mode H. Metric geometry: Area I. Metric geometry: Volume	
II Algebra	35% - 25%
A. *Symbols and conventions* B. Evaluating explicit expressions with and without grouping symbols C. Evaluating expressions with variables D. Equations, formulae, and functions E. Monomials F. Polynomials G. Products and factoring H. Graphing linear and selected equations I. Systems of equations J. Exponents K. Scientific notation L. Progressions and series	
III Plane Geometry	15% - 13%
A. Points, lines and planes B. Relationships between lines and angles C. Triangles: congruencies, inequalities D. Similar polygons E. Circles, arcs, and angles F. Constructions and loci G. Trigonometry H. Logic and proof: Pythagorean theorem	

- instructional continuity -- AI topics should yield a clear sequence of tasks and subtasks leading to mastery of objectives used as building blocks within and between AI lessons.

- functional context -- AI GED math topics should be amenable to presentation so as to emphasize steps and applications as early as possible (rather than theory and abstraction) using problems having face validity with respect to the GED and life situations.

- target group appeal -- AI topics should be presented at a level of reality that provides practical interest, tutorial support, and game-like appeal in anticipation of trainees with relatively low academic potential or aspiration level and ambivalent motivation.

- support requirements -- AI topics should be within the capabilities of the display device, i.e., they should not require (or only minimally require) off-line displays, student tools, and personnel support.

- time segments -- AI topics should be attainable in the experimental setting in a 3-4 hour time block, on the average, with consideration given to individual differences in abilities and motivation.

- mixed strategies -- AI topics should allow a multiple working hypothesis on the utility of AI for teaching mathematics. The choice of topics should permit an eclectic mix of learning and instructional programming strategies and techniques, ensuring a sample which may have wider application. For example: (1) teaching the learner a procedural approach to solving word problems should have applicability to decimal, percent, and other kinds of word problems; (2) an instructional programming strategy which creates subroutines for generating whole number and decimal practice problems in real-time should have carryover to generating other kinds of practice problems or to generating pools of equivalent

test items; (3) a strategy for moving learners into and out of instructional segments according to their performance on a sample of diagnostic test items, or a strategy which adjusts a learner's rate of progress according to his preference or confidence, should enhance gain scores and motivation and, undoubtedly, will achieve variability in terms of rate of progress of individual students.

The topics in Table 2-1 were analyzed with respect to the above criteria. The constraint on support graphics and student learning tools, combined with the relatively low GED emphasis and limited experimental time, ruled out including metric geometry, plane geometry, and graphing in algebra.

Instructional continuity could be maintained by teaching a building block string of objectives beginning with basic decimal arithmetic, supplemented by whole number arithmetic, as required, and building into basic percent operations and percent work problems at graded levels of difficulty. The concept of "variable" could be introduced with percent, supporting its use later in algebra. The skills gained with decimals and with word problems would also, in some measure, support a unit on graphs and averages. In the interest of the limited experimental time block, it was decided to avoid teaching fractions, and also to extend a majority of the general math topics to the level of word problem applications without introducing unnecessary mathematics jargon. Finally, based upon first-hand knowledge of the capabilities and limitations of the CAI software, it was decided that a string leading from decimals into percent, and on to data interpretation and a practical subset of algebra, would allow ample opportunities for incorporating a variety of instructional strategies and techniques.

Based upon the preliminary analysis just described, four GED math subject areas were selected for conversion to the GED AI instructional format. The four units and their topics were:

1. Decimals
   a. Place values
   b. Rounding
   c. Basic arithmetic operations
   d. Solving decimal word problems
2. Percent
   a. Numeric equivalents of percent
   b. Basic percent operations
   c. Solving percent word problems
3. Interpreting Data
   a. Grouping of data
   b. Reading bar and line graphs
   c. Computing an average
4. Algebra
   a. Symbols and vocabulary
   b. Algebraic expressions
   c. Order of operations--use of grouping symbols
   d. Word phrases as algebraic expressions
   e. Simplifying expressions
   f. Solving word problems using algebra

In subsequent analysis, learning objectives and test items were developed for these four areas according to procedures described below. Decision on final selection from among these topics was deferred until a review of the objectives and test items for these four topics had been completed by USAFI subject experts. The outcomes of this review are implicit in the subsequent developmental steps.

2. Preparation of Task Hierarchy Charts

For each candidate unit in the GED AI group—decimals, percent, data, and algebra, SDC prepared a Task Hierarchy chart. These block diagrams depict graphically the relationships among mathematics applications tasks, task elements, and subelements. A prerequisite, hierarchical relationship is identified among the tasks and elements shown on the block diagrams. Level in the hierarchy is indicated by the decimal numeration scheme and the connectors between the boxes. This decimal numeration scheme remains consistent through all the training analysis materials--Content Development outlines, Task Hierarchy charts, Training Analysis Information Sheets, Criterion and Enabling Objectives and their corresponding test items--so as to permit cross-reference.

Figure 2-2 shows a Task Hierarchy chart for the word problems topic of the decimals unit. Other Task Hierarchy charts prepared for the GED AI module are contained in Appendix A.

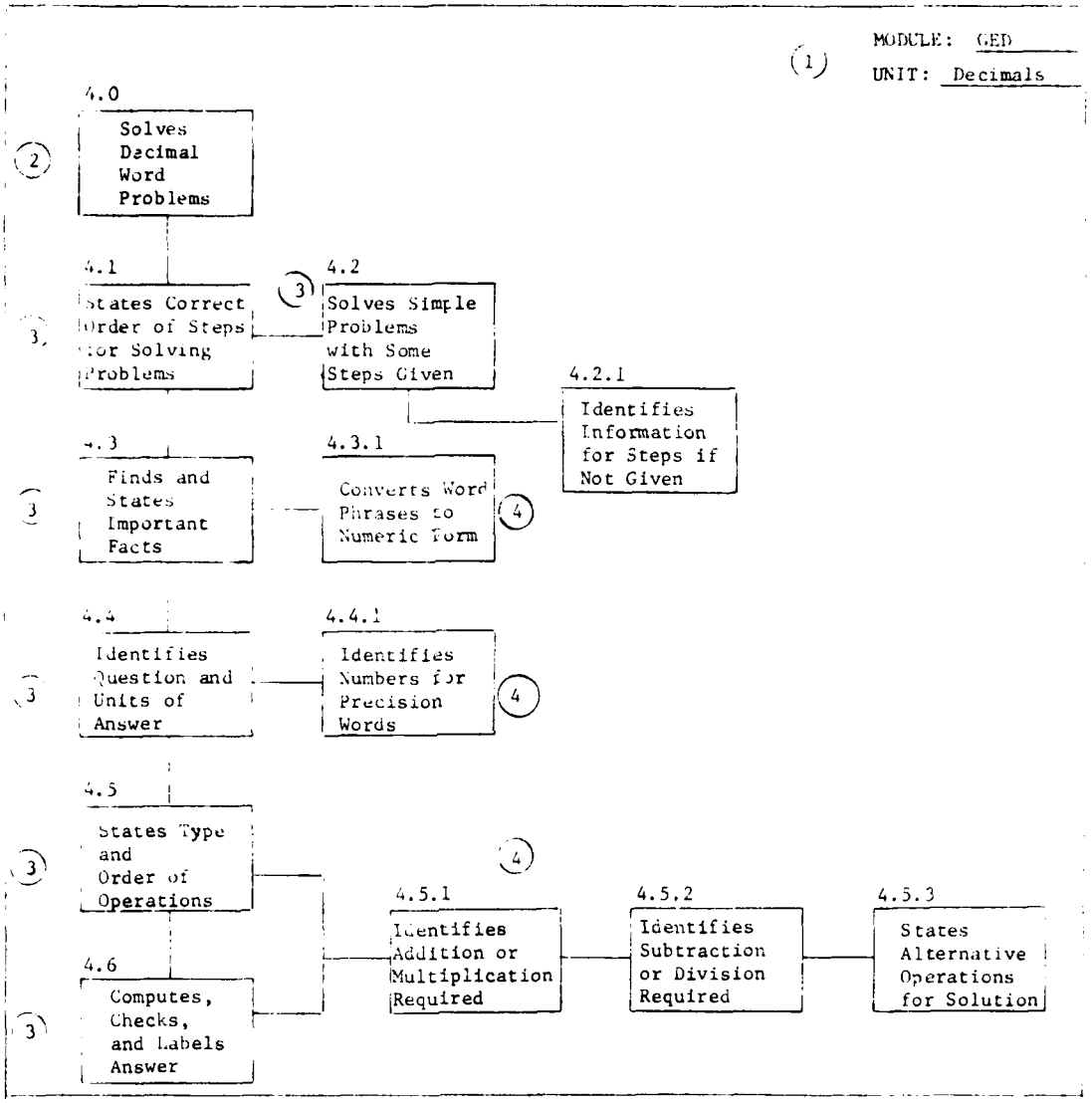
3. Preparation of Training Analysis Information Sheets

SDC prepared a Training Analysis Information Sheet (TAIS) for each candidate GED topic. The TAIS is shown in Figure 2-3. The major task identification number is carried at the top, with numeration of tasks at second and third levels appearing in the Task Element and Subelement columns. For each major task the conditions in which task performance is embedded are stated, as are the performance standards required to evaluate mastery of the criterion test items assessing task performance. Supplemental training materials additional to the AI module are also listed, as required. Only one GED unit, Interpreting Data, requires supplementary materials--pictures of line and bar graphs. The complete set of Training Analysis Information Sheets for the GED AI courseware is provided in Appendix A.

Review of the candidate topics and Training Analysis Information Sheets was accomplished in conjunction with review of instructional objectives and test items. Procedures and results of the USAFI review and concurrence meeting are presented in paragraph C.4., below.

C. DEVELOPMENT OF INSTRUCTIONAL OBJECTIVES AND TEST ITEMS

The development of instructional objectives and corresponding test items (Step 2.0, Figure 2-1) from the Training Analysis Information Sheets was the next task performed in developing the GED AI math courseware.



EXPLANATORY NOTES:

(1) Identification -- indicates the AI module as GED and the unit as decimals. The units are: decimals, percent, interpreting data, and algebra.

(2) Major Task (1.0...4.0) -- the box contains a statement of the major performance task for a topic within the unit. The number indicates the sequence of this topic/task in relation to all topics selected for this instructional unit (e.g., 4.0 indicates that this is topic number 4 and the fourth major applications task in the sequence of tasks for decimals unit). The task number commences at 1.0 for each topic within each of the four GED units.

(3) Task Element (1.1...4.6) — each box represents one or more subtasks of the major task. The ascending decimal number indicates the general prerequisite relationship.

(4) Task Subelement (1.1.1...4.5.3) — each box represents a subtask determined to be a prerequisite for the task element. The ascending decimal number indicates the general order of precedence.

Figure 2-2. Task Hierarchy Chart for the Word Problems in the Decimals Unit of the GED AI Module

TAIS No. 3004 (1)

(2) MODULE GED
UNIT Decimals
TOPIC Solving Word Problems

TRAINING ANALYSIS INFORMATION SHEET

(3) 1. TASK IDENTIFICATION: 4.0

(4) 2. TASK: Solves word problems by determining and performing individual or successive steps of decimal number addition, subtraction, multiplication, division, and rounding of answers.

(5) 3. CONDITIONS: Given word problems with decimal numerals or quantifiable word phrases.

(6) 4. STANDARD: No errors in last three of four criterion problems

5. TASK ANALYSIS:

TASK ELEMENTS (7)	SUBELEMENTS (8)	SUPPLEMENTAL TRAINING MATERIAL (9)	REFERENCES (10)
4.0 Solves word problems and states answers to 4.6 precision specified.	4.1 Sequence steps into correct order for solving word problems. 4.1.1 Solves simple word 4.2 problems and identifies information for each step where not given. 4.3 Finds and states important given facts. 4.3.1 Converts word phrases of quantity to decimal numerals. 4.4 Identifies question to be answered and units of answer. 4.4.1 Identifies numbers for words specifying precision. 4.5 States required arithmetic operation(s) and correct sequence of operations. 4.5.1 Identifies where addition or multiplication is required. 4.5.2 Identifies where subtraction or division is required.	None	U.S. Dept. of Labor. AGEP High School Self Study Program. Solving Decimal Word Problems. PM 431-26, 1969. Hockett, S. GED Mathematics Home Study Guide, Lessons 8 and 9. Barron's, 1972. UCMP Revision Project. How to Teach Students to Solve Math Story Problems (DRAFT) SDC, 1972.

Figure 2-3. Portion of a TAIS for a GED AI Math Topic (Sheet 1 of 2)

EXPLANATORY NOTES:

(1) TAIS No. -- The TAIS identification number. For the GED math topics, the sequence runs from 3001 through 3016.

(2) Module Unit Topic -- The module identification, GED, indicates that this TAIS pertains to the GED preparatory AI materials. The unit designation indicates the four major subject areas, while the topic for a unit corresponds to a major task:

Unit	Topics
Decimals	Place Values, Rounding Decimals, Basic Decimal Arithmetic Operations, Solving Decimal Word Problems
Percent	Numeric Equivalents of Percent, Basic Percent Operations, Solving Percent Word Problems
Data	Grouping of Data, Reading Graphs, Computing an Average
Algebra	Symbols and Vocabulary, Basic Expressions, Order of Operations, Word Phrases as Algebraic Expressions, Simplifying Expressions Solving Word Problems with Linear Equations

(3) Task Identification -- The identification number of the task (topic), commencing with 1.0 for each GED unit. This identifier corresponds to the highest level tasks on the Content Development outlines and Task Hierarchy charts, and to criterion objectives and criterion test items.

(4) Task -- A behavioral statement of the mathematics application skill to be demonstrated.

(5) Conditions -- Statements indicating the context in which the task must be demonstrated--the "givens."

(6) Standard -- The standard considered adequate to ensure that task learning has occurred under the stated conditions.

(7) Task Elements -- A more explicit breakdown of how the task will be demonstrated, e.g., as a set of subtasks, as a series of problems, etc.

(8) Subelements -- Subtasks supportive of the Task Elements. The assumption is that each must be taught or mastery demonstrated before proficiency on the task and task elements can be taught.

(9) Supplemental Training Material -- Materials required to perform the task in the learning situation. SDC-produced diagrams issued as handouts in support of the task Conditions.

(10) References -- Primary source documents and materials supportive of the training analysis and AI development.

Figure 2-3. Portion of a TAIS for a GED AI Math Topic (Sheet 2 of 2)

Behaviorally stated instructional objectives lead directly to the development of criterion-referenced test items. The sequencing of objectives and items indicates the major checkpoints in the AI material and is the base from which instructional content is developed. Two types of instructional objectives were developed for the GED courseware: (1) criterion objectives, and (2) enabling objectives.

Criterion objectives are end objectives associated with a specific task, each objective specifying the type of performance required and the information given to prompt the performance. They were derived from the Task Elements on each TAIS. Enabling objectives are the objectives to be mastered enroute to the criterion objectives. They are specified in the same form as criterion objectives, but were derived from the Subelements column of the TAIS.

1. Development of Course Outline

As a first step, the SDC staff developed a Content Development Outline for each unit within the GED module. This outline presented topics, subtopics, and teaching points in parallel with specific tasks and subtasks from the Training Analysis Information Sheets. Production of these outlines forced a basic structure and sequence to the mathematics content and, thereby, to the objectives and test items that were developed from the TAIS. Part of the Content Development Outline for the decimals unit is shown in Figure 2-4. The outlines for all four GED units are presented in Appendix A.

2. Development of Instructional Objectives

Criterion objectives were developed for each Task Element specified on the Training Analysis Information Sheets. Enabling objectives were developed for Subelements on the TAIS to indicate, on a more detailed level, the knowledge and skills required of an individual to master the criterion objective. Each instructional objective was stated in behavioral terms. Figure 2-5 shows a sample Criterion and Enabling Objectives Worksheet. Additional Criterion and Enabling Objectives Worksheets were used, as required, to cover all of the tasks on the TAISs. Refer to (Appendix A) for a complete set of Criterion and Enabling Objectives Worksheets developed for the GED math courseware.

MODULE GED
UNIT Decimals

CONTENT DEVELOPMENT (Cont'd)

Subject Matter Outline	General Task/Objectives
D. Where divisor is larger than dividend.	3.4 Obtains quotients from decimal dividends divided by whole number and decimal divisors.
E. Rounding off uneven quotients.	
IV. Solving Decimal Word Problems	4.0 Solves word problems requiring individual or successive steps of adding, subtracting, multiplying, and/or dividing decimal numerals.
A. Examples: GED and life analogy.	4.1 States correct order of steps in problem solving.
B. Five steps in procedure for solving word problems.	4.2 Identifies and performs problem solving steps in problems of increasing difficulty.
C. Reading problem carefully to find important words.	4.3 Identifies important problem facts.
D. Picking out and stating the facts; converting word phrases to numbers in finding facts.	4.4 Identifies question to be answered and answer units.
E. Finding the question to be answered and the answer units; recognizing the precision required for an answer.	4.5 Decides type and order of arithmetic operations required.
F. Deciding upon the type of operation(s) required; word clues to determining if things are coming together, separating, coming together in equal sized sets, or separating into equal sized sets.	4.6 Obtains and labels the answer.
G. Problems where more than one type and sequence of operations is possible.	
H. Working the problem; computing, checking, and labeling an answer.	

Figure 2-4. Portion of Content Development Outline for a GED AI Math Unit

TAIS No. 3004

(1) MODULE GED
UNIT Decimals
TOPIC Solving Word Problems

CRITERION AND ENABLING OBJECTIVES

(1) TASK IDENTIFICATION: 4.0

(2) TASK ELEMENTS: 4.1 - 4.6
4.1.1 - 4.5.3

CRITERION OBJECTIVE(S) (3)	ENABLING OBJECTIVE(S) (4)
4.0 Given three word problems, each requiring a different series of arithmetic operations with decimal numbers, SOLVES the problems and STATES the answers obtained to the precision specified.	4.1 Given a scrambled list of the five steps for solving word problems, ORDERS the steps into the correct sequence for problem solving. 4.2 Given two word problems, one requiring 4.1.1 a subtraction and the other a multi- 4.5.1 plication of two decimal numbers, student: (4.3) reads the problem and IDENTIFIES important facts; (4.4) STATES the question to be answered; (4.5) STATES the type of arithmetic operation to be performed; (4.6) solves the problem and STATES the remainder or the product with named units of measure. 4.2 Given a word problem requiring a divi- 4.1.1 sion of decimal numbers, student: 4.5.2 (4.3) STATES the important facts; (4.4) STATES the question to be answered; (4.5) STATES the operation to be performed; (4.6) solves the problem and STATES the quotient in minutes. 4.2 Given a word problem where the solu- 4.1.1 tion is either by a division and a 4.5.3 multiplication, by two divisions, or by addition, student: (4.5) STATES correct sequence of one set of operations; (4.6) solves problem and STATES answer in minutes.

Figure 2-5. Portion of Criterion and Enabling Objectives Worksheet for a GED AI Math Topic (Sheet 1 of 2)

EXPLANATORY NOTES:

(1) TAIS No.
Module
Unit
Topic
Task Identification
-- Same identifications as appear on the TAIS. Each TAIS has a matching Criterion and Enabling Objectives worksheet.

(2) Task Elements -- Numeric code identifying the range of TAIS Task Elements and Subelements covered by these objectives.

(3) Criterion Objectives -- Criterion objectives are prepared for the Task Element(s) as identified on the corresponding TAIS. A Criterion Objective may be prepared for each Task Element or may include all Task Elements. The number associated with the Criterion Objective identifies the Task Element(s) for which the Criterion Objective corresponds.

(4) Enabling Objectives -- Where appropriate, one or more Enabling Objectives are prepared for each Criterion Objective. The number indicates the Criterion-Enabling Objective correspondence and sequence in which the Enabling Objective is to be presented within the instructional material.

Figure 2-5. Portion of Criterion and Enabling Objectives Worksheet for a GED AI Math Topic (Sheet 2 of 2)

3. Development of Criterion and Enabling Test Items

SDC developed criterion and enabling test items which were keyed directly to the criterion and enabling instructional objectives. Since test items can serve as indicators of how well the student masters instructional segments, considerable attention was given to their development. To aid test items specification, the following guidelines were adopted and attempts made to judiciously adhere to them.

- Whenever possible, test items should be performance oriented and require that the student demonstrate skills and knowledges directly related to the criterion objectives.

- Each test item should elicit measurable behavior.
- The structure of the test item should be positively oriented.
- Test items requiring constructed responses are preferable to multiple-choice items because they require the formulation of a response and a commitment, rather than a "best guess" from a menu of choices.
- Multiple-choice items should be used when selecting or discriminating is central to the objective, or where AI software or instructional programming limitations preclude adequate evaluation of a constructed response.
- The test item must be amenable to AI presentation.

Figure 2-6 shows a Test Items Worksheet. Correct answers to Criterion and Enabling test items are indicated by a constructed response or multiple-choice letter enclosed between parentheses and underscored. Where multiple-correct constructed responses were anticipated, these are entered between parentheses, with each response underscored. Additional Test Items Worksheets were used as required to cover all of the objectives on the objectives worksheets. Appendix A contains the complete set of Test Item Worksheets for the GED AI math courseware.

4. USAFI Review and Final Selection of Subject Matter

Work efforts in the selection of GED AI topics, including preparation of instructional objectives and test items, culminated during the month of March 1973 with the production of a working paper titled, "Automated Instruction Training Analysis for the GED Mathematics Module." This working paper underwent review (Step 3 of Figure 2-1) by mathematics and curriculum experts at USAFI Headquarters, Madison, Wisconsin.

Participants at the USAFI review meeting included:

Dr. Clay Brittain, Director of Research and Evaluation
Dr. Brothers, Deputy Director, USAFI
Ms. Bouri Davis-Flesch, Education Specialist
Dr. Donald Niederkorn, Education Specialist-Mathematics
Mr. Ripley Sims, Education Specialist
SDC Project Staff

The content and structure of the working paper were described for the committee and they were then asked to perform three tasks using materials provided by SDC. The tasks were:

Task 1: Determine the relative importance of the GED mathematics subject areas (those shown in Table 2-1) for inclusion in the AI experiment.

Task 2: Prioritize the four units and unit topics covered by the SDC AI working paper for inclusion and relative emphasis in the AI experiment.

Task 3: Review the SDC training analysis working paper for completeness, content, difficulty, and accuracy.

To facilitate the two prioritizing tasks, SDC produced two rating scales: one for the GED Mathematics Subject Areas (Task 1) and one for the Automated Instruction Modules (Task 2). Each of these made us of a five-point scale whereby topics could be rated from "Highly Suitable," through "So-So," to "Not Suitable." A sample set of the rating materials is contained in Appendix B.

The USAFI reviewers first concurred that the SDC rationale for subject matter selection had resulted in the most appropriate choice of four units from among the potential GED mathematics subject matter, and that the priority for unit inclusion should be: the three General Mathematics units--Decimals (priority 1), Percent (priority 2), Interpreting Data (priority 3)--and the Algebra unit (priority 4). This obviated the task of rating all the GED math subject areas independently.

TAIS No. 3004

MODULE GED
UNIT Decimals
TOPIC Solving Word Problems

TEST ITEMS

TASK IDENTIFICATION: 4.0

TASK ELEMENTS: 4.1 - 4.6
4.1.1 - 4.5.3

CRITERION ITEM(S)	ENABLING ITEM(S)
4.0 Think carefully and take your time on these last three problems. I want you to get at least two right. Jim earns $24.53 per day. Each day he spend $.80 on carfare, $4.50 on food and drink, $.10 on a newspaper, and $.45 on cigarettes, and at night he rents a hotel room for $8. At the end of a day and a night, how much money does Jim have left? ($10.68, 10.68, 10 68) A storage room measures 15.6 feet by 10.2 feet. Another storage room measures 20.9 feet by 14.4 feet. Find the total storage space for the two rooms combined to the nearest tenth of a square foot. (460.1 square feet, 460.1, 460.08) Truck No. 1 is able to travel thirteen and eight tenths miles on a gallon of gasoline, and its tank can hold eighteen and four tenths gallons. Truck No. 2 is able to travel fourteen and three tenths miles on a gallon of gasoline, and its tank can hold sixteen and nine tenths gallons. Which truck is able to travel farther on a full tank of gasoline? (1, one) How much farther can truck 1 travel? (12.25 miles)	4.1 Here are the 5 steps for solving word problems. A Decide which operations are to be performed B Pick out the important facts C Read the problem carefully D Compute, check, and label the answer E Pick out the question to be answered Put these in the order in which they should be performed (type the letters on a single line) (C B E A D , CBEAD) 4.2 4.1.1 4.5.1 A carpenter needs a wooden brace to fit between two studs that are 16.35 inches apart. He has a piece of lumber 20.9 inches long from which to make the brace. After making the brace, how much lumber will he have left over? There are two important facts in this problem What is one fact? (key words & numbers) The other fact is...? (brace 16.35 lumber 20.9, 16.35 20.9, 20.9 16.35) What is the question being asked? What does the problem want to know? (lumber left, inches, left over, leftover) What arithmetic operation must you use to solve this problem? (20.90-16.35, 20.9-16.35, subtraction, subtract, minus, -, take away) Now compute your answer. (4.55 inches, 20.90-16.35)

Figure 2-6. Portion of Test Items Worksheet for a GED AI Math Topic (Sheet 1 of 2)

EXPLANATORY NOTES:

(1) TAIS No.
Module
Unit
Topic
Task Identification
-- Same identifications as appear on the TAIS and on the Criterion and Enabling Objectives Worksheets.

(2) Task Elements -- Same numeric code, identifying the range of TAIS Task Elements and Subelements, as appears on the Criterion and Enabling Objectives Worksheet.

(3) Criterion Item(s) -- Criterion items are prepared for each criterion objective. The criterion item may correspond to one or more Task Elements on the TAIS. There may be more than one item to measure a given criterion task. The statements labeled TASK and CONDITIONS on the TAIS are used to derive the content and context of the test item(s), while STANDARD denotes criteria for mastery. The number of the Criterion Item identifies the associated Criterion Objective.

(4) Enabling Item(s) -- Enabling Items are prepared for each enabling objective and serve as diagnostic checkpoints to test a skill or knowledge that is required for successful performance on each criterion objective. The number indicates the Enabling Objective--Enabling Item correspondence.

Figure 2-6. Portion of Test Items Worksheet for a GED AI Math Topic (Sheet 2 of 2)

Next, the three USAFI education specialists assigned relative emphasis indices to each of the topics within the four AI units. Instead of using the five-point scale, for each of the topics within a unit they assigned a relative-percent-of-emphasis figure such that their total for each unit would be 100 percent. Table 2-2 shows the composite results of their ranking as an average percent emphasis and a corresponding rank order for relative emphasis of topics.

TABLE 2-2. TOPIC EMPHASIS RANKINGS FOR GED AI MATH

AI UNIT	COMPOSITE PERCENT	COMPOSITE RANK
1 Decimals		
Place Values	10	3
Rounding Off	5	4
Basic Operations	50	1
Solving Word Problems	35	2
2 Percent		
Equivalency of Numbers	25	3
Basic Operations: Simple Word Problems	40	1
Solving GED-type Word Problems	35	2
3 Interpreting Data		
Grouping Data	40	2
Reading Graphs	45	1
Computing an Average	15	3
4 Using Algebra		
Algebraic Symbols and Vocabulary	17	2
Basic Expressions	14	4
Grouping Symbosl	12	5
Words as Algebraic Expressions	10	6
Simplifying Expressions	15	3
Solving Word Problems	32	1

The implication of these rank-orderings on subsequent AI development was that the total instructional burden--the number of objectives and test items, and the amount of time for student instruction and practice--was adjusted according to the weighting implied by the rankings. However, the rank-orderings were not treated as priorities for exclusion where some coverage of lower priority topics was necessary for higher priority topics. Moreover, it was decided during the review meeting to drop the unit of Algebra from the AI development, as well as the topic on grouping of data (Task 1.0) from the unit on Interpreting

Data, because it was highly unlikely that the 3-4 hour AI experimental block could include all four units and because these could be dropped without disrupting the instructional continuity among the remaining topics.

During review of the SDC working paper, all of the reviewers agreed that the SDC approach of teaching students a stepwise strategy for solving word problems was essential and that, because of their heavy emphasis on the GED, practice with word problems should be spread as evenly as possible throughout the AI topics. Some of the specific suggestions which emerged from the review were as follows:

- Drop two of the more difficult word problems from the Percent unit (Task 3.0, TAIS 3007) or make them optional for the students performing to criterion standard on the less difficult problems. The latter strategy was used in the final AI materials, lesson PERC3.
- Adjust distractors on several multiple-choice questions to make them less alike or more realistic (e.g., Percent test items 3.1 and 3.2, TAIS 3007).
- Add whole numbers'drill and practice for slower learners on naming, borrowing, and carrying whole numbers as optional prework for decimals. This was done by incorporating lesson DEC 3 into the final AI materials.
- Tie the SDC approach of breaking word problems down into components of part, whole, and percent to the P=BRT formula.

In addition, guidelines suggested by reviewers for the subsequent development of materials included using the cadence of speech to enhance readability, keeping the pace fast and reducing student tension with easy frames, keeping related ideas together in word problems and emphasizing the pattern and syntax form for different types of word problems, and keeping motivation to master the GED as the student's primary goal.

This review activity led SDC to make changes to the TAISs, instructional objectives, and test items as needed to delete material or to review the relative emphasis, as well as to incorporate some of the suggestions on style and technique. This updated material is contained in Appendix A. Training analysis information for Algebra and for the data grouping topic in the unit on interpreting data are included in Appendix A, even though they were dropped from AI development and remained unmodified subsequent to the review meeting.

Following this review meeting and the corresponding adjustments noted above, SDC's GED courseware development focused entirely on AI materials for decimals, percent, and interpreting data, including the on-line pretests and posttests for each of these units.

D. DEVELOPMENT OF COURSE MATERIALS

The development of instructional materials proceeded from layout of lesson content and sequence, through incorporation of instructional strategies and encoding of the AI material, to technical critique and preliminary on-line checkout (Steps 4.0 through 7.0 of Figure 2-1). This phase of GED AI materials development took place during the April through July 1973 time period.

SDC was to develop 12 hours of GED AI material from which approximately 4 hours would be selected for use within the experiment. The material was to be individualized for self-paced presentation within the AI field experiment setting. The instructional sequences were to be specified in a manner consistent with the goals of:

- Demonstrating successive mastery of enabling and criterion objectives.
- Achieving variability in time-to-mastery as a concomitant of the student's own pace and the extent to which lessons adjust to accommodate students of higher and lower abilities.

Two additional factors had considerable impact upon the design and development of AI courseware--the capabilities and limitations of:

- PLANIT, the AI applications software and user language
- The student communications device (cathode ray tube display with alphanumeric keyboard).

1. Development of Lesson Content and Sequence

To begin production of the GED AI materials, SDC examined the topics specified for each of the GED units to determine how the 12 hours of total instructional time should be allocated. The USAFI priority rankings (Table 2-2 above) provided the basis for adjusting and constraining the objectives for certain topics. Analysis of the topic content, the relative number of enabling and criterion objectives in each unit, and the possible strategies for adjusting the topics to individual student abilities indicated that the bulk of instructional time would go into the units on decimals and percent, as follows:

UNIT	EST. OF ON-LINE TIME
Decimals (with whole numbers supplement)	3-6 hrs.
Percent	3-5 hrs.
Interpreting data	1-3 hrs.

Two types of instructional materials was required: AI lessons, and--for the unit on interpreting data--printed bar and line graphs to support the on-line instruction and testing.

Each major task (topic), as specified on a Training Analysis Information Sheet (TAIS), became the basic instructional production unit. For each task, the associated content development outline, task hierarchy diagrams, TAIS, criterion and enabling objectives and test items were reviewed. A basic instructional

sequence was determined for the task which proceeded from one criterion test item to the next, with enabling objectives appropriately interspersed according to the prerequisite order diagrammed on the task hierarchy charts. In this way, a basic lesson structure was developed.

A series of frames was prepared in conjunction with each enabling or criterion test item in the lesson sequence. Each frame was designed to perform one or more of the following functions:

- Present content information, examples, test items, practice problems, instructions, or lesson control choices to the student
- Evaluate student response as correct, incorrect, neutral, or unanticipated
- Provide feedback messages appropriate to the category of response and, in many cases, to the particular correct or incorrect response given
- Decide on the next action to be taken, i.e., await another response, proceed in sequence, skip elsewhere in the lesson, or skip to another lesson.

These basic frame capabilities were exercised by the SDC lesson author using character presentation, answer matching, and lesson control statements of the AI user language, PLANIT.

A number of resources were used at this stage in determining the basic content information and style suitable for the target group of students. In addition to the non-SDC and SDC Job Corps mathematics revision materials cited earlier (paragraph 2.B.1) and the suggestions which had emerged from the aforementioned USAFI review meeting, the following material provided useful examples of style, techniques, and vocabulary level:

- Mathematics for Adults. Self-study pads under development and evaluation by USAFI

  A038.01, Addition and Subtraction of Whole Numbers

  A038.05, Part 1: Multiplication of Whole Numbers
  Part 2: Division of Whole Numbers

  A038.12, Part A: Solving Verbal Problems
  Part B: Sizing up Multiple Choice
  (Mixed diagnostic problems in fractions, decimals, mixed numbers, volume, measurement, rounding, etc.)

- Post, D. (ed.) The Use of Computers in High School Mathematics. Chapters 5 and 6, ENTELEK Inc., Massachusetts, 1970.

In creating the *frames of content information*, an attempt was made to adhere to several groundrules of instructional style, i.e., to

- Let the student know where he is going and why that is important, as a goals and context organizer at the start of each lesson
- Inform the student how he has done over sets of subgoals
- Provide clear instructions--avoid ambiguity of what is required
- Keep information and feedback as straightforward and concrete as possible
- Wherever possible, avoid use of mathematics terms which do not appear on the GED test (e.g., numerator, denominator, dividend, divisor, etc.)
- When feasible, use diagrams on the display scope to enhance verbal comprehension
- Try to teach students how to break word problems into components, and a step-by-step procedure for solving the problems

Techniques were used to gain and sustain student confidence and interest. An attempt was made to keep the material light by introducing concepts, procedures, and problems in the context of the infantry MOS, money, common tools, cars, sports, and girls. For the topic on rounding decimals, it was decided to introduce the main examples through a gamelike interaction. A very modest attempt was made at humor in occasional lead-in phrases and in feedback to certain unwarranted responses. However, most of the forms of humor originally considered were dropped later in the development phase, due to an ambivalent expectation with respect to effects. Frames for enhancing motivation and gaining learner interest through games with payoff (e.g., "you can become a percent sharpshooter or percent expert and receive a certificate that proves it, if you get three of the next four word problems") were dropped for similar reasons.

The composite of frames constructed for each task became a named AI lesson, except where software limitations necessitated breaking a logical lesson into two parts. For example, task 1.0 of the decimals unit became lesson DEC1 on place values, topic 2.0 for the decimals unit became lesson DEC2 on rounding off decimal numbers, and so forth. Where it became predictable that software limits for an AI lesson would be exceeded, as with task 3.0 of the decimals unit, subobjectives dealing with optional prework on whole number arithmetic were broken out into a separate AI lesson. Thus task 3.0 comprises AI lessons DEC3 (whole number arithmetic) and DEC32 (decimal arithmetic).

2. Development of Instructional Strategies

The next step was to develop instructional strategies as overlays incorporated into the basic sequence. The main aim of these strategies was to let the most able or most confident students progress as fast as warranted, while providing tiers of help and review for those students who evidenced predictable difficulties or opted for more help. Another purpose of these strategies was to maximize the lesson coding efficiency for information display within constraints of the student communications device.

SDC viewed the formulation of instructional strategies from two broad levels. This encompassed strategies that would have application across as well as within lessons. Further, it was SDC's desire to capitalize upon those capabilities of PLANIT that are provided to assist both the author in preparing the instructional material and the student in receiving it. Decisions were made which governed presentation, answer-matching, feedback, entry point control, enroute control, and lesson-to-lesson control for each lesson. In some cases these decisions on strategy were lesson-specific and in other cases they applied across lessons. The strategy designs employed are discussed in the following paragraphs.

a. Presentation Strategies

- As noted earlier, a straight instructional path was prepared for each topic which led the student through the enabling objectives to the criterion objectives. An attempt was made to hold the language level constant for any path taken in a lesson, introducing specialized terms only when needed to most clearly present instructional content, or where they might aid in comprehending or working the types of problems encountered.

- In nearly all cases, on-line representations of instruction, examples, and problems were used. Where this was impractical, adjunct materials were prepared for use by students.

- In presenting drill and practice on whole numbers and decimal arithmetic operations, a strategy was used which specified the form and boundary values of the problems to be generated, letting the AI software generate the actual numeric values for each student and for each iteration of the problem. This technique was not applied to criterion problems in the GED AI lessons because of the need to ensure adequate experimental control over test items. However, the technique could be used

to generate test items equivalent in syntax and boundary conditions when using AI for testing.

- Special strategies were employed to control the amount and mix of information on the student's display screen. The student's UIOD (User Input/Output Device) limited AI presentations to the top 18 lines of the CRT screen. This meant there were 17 lines for lesson presentation, because line 18 was reserved for automatic printout of an asterisk (*) from the AI software to cue the student when a response was required. A "roll-up" function caused old information on the screen to be completely or partially removed, depending on the number of new lines of information requiring display, and no hardcopy output was available. Therefore, AI frames were developed to contain no more than 17 lines for any given presentation. Two techniques were employed for special cases:

  - Whenever two related and successive presentations would exceed 17 lines, the first presentation was held on the screen until the student indicated that he was ready to go on. This required a number of neutral response frames which merely accepted the response of "GO."

  - When the same information needed to be retained on the screen along with the presentation of a series of questions about that information (e.g., word problems requiring 12 lines with a question requiring 2 lines), frames were prepared that would cause the AI software to retrieve the problem information and then select the next question in sequence. These iterations of displaying information from one frame mixed with a question from another frame were continued until the student had answered all pertinent questions. There was no loss of information to the student as long as the combination of feedback, problem information, and the next question did not exceed 17 lines.

b. Answer-Matching Strategies

- The large majority of GED AI materials asked for constructed responses--numbers, numeric expressions, single words, combined text and numbers, key words, short phrases, and even one-line sentences. Where phrases and sentences were possible responses, every attempt was made to detect key words and numbers.

- Both for frames requiring constructed responses and frames requiring a multiple-choice selection, correct as well as incorrect response variations were anticipated, to assist the student in mastering the material by providing appropriate feedback. Incorrect responses served a diagnostic purpose for selecting the next action on the basis of a specific difficulty.

- Answer-matching service routines of the AI software were used to the greatest extent practical in order to detect and correctly match correct, incorrect, and neutral responses. This included:

  - Matching phonetically equivalent responses to permit students to receive credit for those answers in which correct spelling was not essential.

  - Matching key words and numbers in phrases so as to detect correct, partially correct, and incorrect responses; where order of the key words was considered unimportant, a match would occur no matter what the order of key words in the student's response.

  - Matching numeric answers and numeric expressions as algebraic equivalents of the author's numeric expressions. This was useful where the problem data were generated by the software during lesson execution.

- Automatic matching of equivalent numbers, but only where this was desirable. For example, in some problems the student was automatically considered correct when he answered 2.5 or 2.50. Automatic matching of numeric equivalents was not used, however, in topics where it was critical that the student round his numeric answer to a given place value.

- Matching numeric answers automatically within a specified tolerance. This was useful when, for example, a problem asked the student to give a number which was then used as a parameter in generating his unique problem. For example, in asking the student his current weight and then using that value in a word problem concerning an increase in weight of a given percent after his next vacation, it was possible to detect weights given that were unwarranted.

- Automatic matching on one or more key characters entered by a student in a string of characters so as to detect partially correct or incorrect answers. This was later found to operate unreliably in on-line tests and was, therefore, removed from the lessons.

c. Feedback Strategies

- The student received feedback for each response entered. The feedback was positive or negative according to whether it was for a correct, partially correct, or incorrect response. Neutral, innocuous, or tutorial feedback was provided in an attempt to avoid nonsequiturs when the student's response did not match an anticipated response.

- Prompts were inserted within the instructional material to cue students as to possible available answer choices, to obtain the remaining part of a partially correct answer, provide additional information, or to indicate that a response was required after a time interval had elapsed.

d. Entry Point Strategies

- The instructional starting point within the first lesson of each unit was the same for each student. Three of the five decimals' lessons were designed to locate an instructional starting point based on student performance over a diagnostic sample of test items, or upon student choice. For example, after looking at types of whole number problems, confident students could opt to go directly to decimal arithmetic. Otherwise, they stayed in the whole numbers lesson to see if they were able to correctly answer the arithmetic test items. If they could not do so, they were allowed to choose among types of whole number drill exercises. Having reached the decimals arithmetic lesson, students took a diagnostic sample of test items to see where instruction should begin, allowing them to go directly to the criterion items should they answer correctly each of the diagnostic items. For the lesson on decimal word problems, students were allowed to choose one of three routes based upon their entry level confidence with respect to the stated goals: they could opt to try the criterion problems immediately, take the slowest route of small steps, or take an intermediate route of guided practice on word problems.

- The points of student reentry into a lesson were controlled to maintain instructional continuity in the event that execution of a lesson was interrupted and then resumed, e.g., at a lunch break.

e. Enroute Strategies

- Decision points within the instructional material were specified where the next step was contingent either upon student performance, student choice, or a combination of both. This permitted exposure to additional material or review of previous material, or allowed instructional segments to be skipped subject to a subsequent assessment of performance.

- The number of tries to correctly answer a criterion item or to correctly answer a specified ratio of items in a set of criterion items was specified. Students who failed to meet standards of performance in the designated number of tries were given feedback concerning their performance, followed by exposure to remedial material. The student was then given another opportunity to meet criterion standards of performance.

- If the student was unsuccessful after a review, he was either exposed to additional help material or, if all the material had been seen more than once, he was either taken to the next instructional sequence or allowed to make one of three choices: go back through review, try the criterion problems again, or move ahead. This caused a few students who had not completely mastered a previous sequence to be moved forward to the next instructional segment. However, this approach also caused certain students to be exposed to greater amounts of instructional material than might otherwise have occurred during the 3 or 4 hours of on-line work. The opportunity for added exposure to instructional material, based upon the student's own perception of his needs and confidence, was considered to be of more benefit to the student at this point than was sole reliance on the logic of the lesson. Rather than require a student to cycle repeatedly through the same instructional material until he met criterion, the above strategy was adopted. It was considered impractical to provide unlimited remedial material and still be able to meet project commitments.

- The normal progression is for students to move forward through the objectives, from lesson to lesson and unit to unit. In one case, the percent unit, lessons were linked for movement backward to a decimals lesson and return. If a student repeatedly showed inability to find a given percent of a number, or to find what percent one number is of another, he was looped back for review instruction and drill in decimal multiplication or division, and then resumed where he left off in the percent lesson.

3. Preparation of AI Material

The AI applications software used for encoding instructional materials was PLANIT (Programming Language for Interactive Teaching). PLANIT permits AI lesson authors to construct sequences of frames. There are four types of frames, each type permitting a user to specify instructional functions. Each frame contains groups which accomplish a class of subfunctions (e.g., presenting information, evaluating responses, taking the next action, etc.). Groups, in turn, contain one or more lines of information to be presented, and PLANIT control statements. Instructional content, answer-matching instructions, feedback, and decision rules were encoded as PLANIT frames according to prescribed rules and conventions[1]. Volume II of this report contains details concerning the survey and recommendations made by SDC to the Army for selecting AI system software, and provides amplifying information on how the PLANIT AI software and courseware were integrated to run under the DEVTOS operating system during this project's life cycle.

SDC's commitment was to deliver the completed AI material as card decks to ARI, who would then use the PLANIT off-line lesson-building capability to generate the AI materials as lessons for on-line presentation. Frames containing the course content and statements for control of strategy discussed above were prepared on worksheets from which cards for input to PLANIT could be readily keypunched. The structure of the frames adhered to the PLANIT rules and conventions for developing off-line instructional materials as specified in the PLANIT Language Reference Manual, with one exception: The ampersand (@) was used in place of the backslash (\) as the character for causing a carriage return/line feed, as the SDC IBM 029 keypunch does not contain a backslash.

In constructing AI lesson frames, care was taken to ensure that presentations did not exceed the display screen capacities mentioned earlier. This required

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[1] Bennik, F. D. & Frye, C. H. PLANIT Author's Guide. SDC TM-4422/001/01, 1 October 1970.
Butler, A. K. & Frye, C. H. PLANIT Language Reference Manual. SDC TM-4422/002/01, 1 October 1970.

the author to be constantly cognizant of the line length (maximum of 50 characters) and the number of lines required to present a display, accept a student response, and present feedback and any subsequent instructional display before the next response was required.

For control purposes it was decided to number the frames within each AI unit in ascending order, even though frame numbers that appear within named AI lessons are treated independently by PLANIT. That is, frame 10.00 can appear in any PLANIT lesson, but may not be duplicated within a given lesson. Frames representing enabling and criterion test items were labeled with a mnemonic formed from the identifier that appeared on the criterion and enabling objectives worksheets; for example, the frame for criterion Item 4.2 might be labeled C42, while the frame for enabling test Item 3.1.1 might be labeled E311. This served as a control feature for branching internal to the lesson and for quick reference to ensure that all test items were included. Other frames were labeled at the discretion of the author to serve as reference points within the instructional material. This was useful when lesson listings were used to observe and monitor student progress during the AI field experiment.

When a set of frame worksheets constituting a task was completed, it was submitted to keypunch operators for conversion to punched cards. A special sheet of instructions was prepared to facilitate standardization of effort among several keypunchers. Figure 2-7 depicts a completed GED AI frame encoded in the PLANIT user language and ready for keypunch. A listing was then generated from each set of cards. The author and other project members reviewed the listing for errors and logical inconsistencies. Corrections made to the listing were resubmitted for keypunching and the card decks updated accordingly.

This production cycle was repeated until AI frames had been prepared for all tasks within a unit. Card decks of frames representing these tasks were then grouped to form PLANIT lessons from which another listing was produced. PLANIT limits each named AI lesson module to a maximum of 100 PLANIT frames. There is

no PLANIT limit to the number of named AI modules which can be linked to form a logical lesson unit or course: this is limited only by capacity of the on-line, high-speed storage available. Therefore, a logical lesson was sometimes named as two AI lesson modules in the interest of avoiding the 100-frame limit.

This process was repeated for each unit within the GED AI courseware. Table 2-3 displays the structure of that courseware.

```
1     28.00 Q E121

2IN THE DECIMAL NUMBER 35.0621, THE
 NUMBER 6 IS IN WHAT DECIMAL PLACE?

30 KEYWORD ON
 0 PHONETIC ON
 A+SECOND
 B+HUNDREDTHS
 0 PHONETIC OFF
 A+2ND
 A+2
 B+100THS
 B+100

4A F:YES, THE 'SECOND' PLACE.
 B F:YES, THE SECOND POSITION IS THE 'HUNDREDTHS'
   F:PLACE VALUE.  YOU SEEM TO BE ON TOP OF THIS.
   F:LET'S SKIP AHEAD.  B:AHEAD
 -R:FIRST, SECOND, THIRD ... PLACE ?
 -F:IN 35.0621, THE 6 IS IN THE SECOND
  F:DECIMAL PLACE.  B:29
```

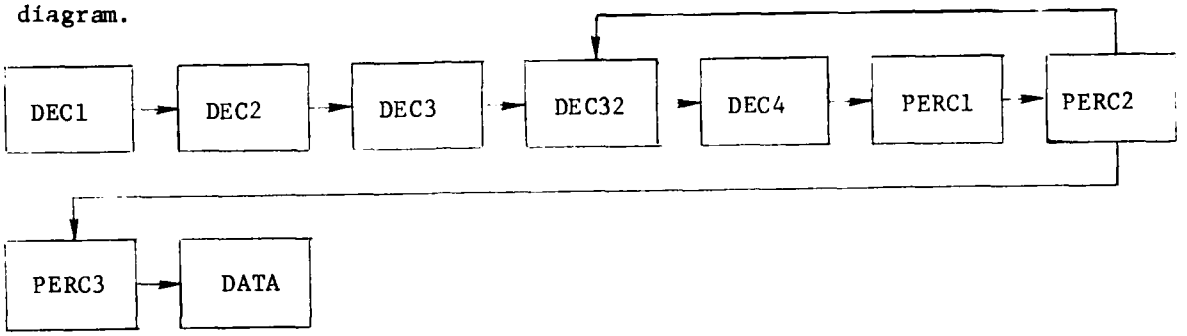
Figure 2-7. Example of a Completed GED AI Frame Ready for Keypunching

TABLE 2-3. GED AI COURSEWARE STRUCTURE

GED UNIT (MODULE)	PLANIT LESSON NAME	TOPIC AND TAIS NO.	FRAME NUMBERS	NUMBER OF FRAMES BY TAIS	NUMBER OF FRAMES BY LESSON	TOTAL FRAMES BY UNIT
Decimals	DEC1	Place Values 3001	10.00-87.00	91	91	
	DEC2	Rounding 3002	100.50-141.00	56	56	
	DEC3	Whole &	301.00-334.00	157	59	
	DEC32	Decimal Arithmetic Operations 3003	335.00-396.00		98	
	DEC4	Decimal Word Problems 3004	401.00-498.00	100	100	
						404
Percent	PERC1	Numeric Equivalents 3005	10.00-83.00	71	71	
	PERC2	Basic Percent Operations 3006	101.00-152.00	53	53	
	PERC3	Percent Word Problems 3007	201.00-284.00	92	92	
						216
Interpreting Data	DATA	Reading Graphs 3009	1.00-48.00	47	69	
		Computing an Average 3010	51.00-70.00	22		
						69

4. Lesson Content and General Design

The overall sequencing of GED AI lesson materials is shown in the following diagram.



As can be seen, progression through the nine AI lessons allowed buildup of skills from decimals to percent and interpreting data. One percent lesson (PERC2) called upon portions of a prior decimals lesson as a subroutine (DEC32) to the extent that students could not master basic percent operations requiring a single multiplication or division. In addition, AI test modules were created for use in the field experiment which would measure the criterion skills possessed by students prior to entering a unit (decimals, percent, and interpreting data) and after completion of a unit. These preassessment and postassessment materials are discussed in paragraph 5, below.

The content and general design of each lesson prepared for GED AI mathematics are indicated below.

a. Decimals Unit

- DEC1 -- Reading and Writing Decimal Numbers
  TAIS 3001--Place Values

  Content: The goals for the decimals unit are stated at the start of the lesson, and the student's common sense application of decimals is assessed by seeing if he can place the decimal point numbers such that three sentences will make sense. If he cannot, after instruction and criterion items he is returned to these questions before exiting the lesson. The

student is tutored successively through concepts of a decimal number, decimal point, decimal place position, and decimal place value. The 'place value line' is used to show the relationship between a decimal digit's position and its place value. When the student can recognize digits for given place values and can name the place values for given positions, he is shown how zeros in a decimal number do and do not change its value. Next, the student is tutored on how decimal numbers can be stated as equivalent fractions and as mixed numbers. The student receives examples and practice items in selecting and writing decimal numbers for quantifiable English phrases, and in writing fractions or mixed numbers for decimal numbers.

Design: The lesson is generally linear in design with only a few opportunities to accelerate past instructional material. If while answering questions on naming the decimal place position (first, second...etc.) the student can also show he can name place values (tenths, hundredths,...etc.), he is skipped past some 25 frames giving instruction on place values. The lesson style is mainly expository, with examples and tutoring. Remedial help is provided as required. If the student fails to show mastery of criterion items, he is returned selectively to review portions in the lesson which address those points that are giving him trouble. If performance is below par after review, he is allowed to select from more review, another try at the problems, or moving on to the next lesson.

- DEC2 -- Rounding Decimal Numbers
  TAIS 3002--Rounding Off

  Content: This lesson builds upon the skills in naming place positions and place values from the prior lesson, DEC1. MOS and other life examples are used where the student sees that "close" (rather than exact) measures are normally made. He learns that a measure becomes less exact as proximity of the last

decimal digit to the decimal point increases, and that limiting the number of decimal places in an answer is called "rounding." The major rules of rounding are introduced in a series of gamelike interactions between student and computer. The student is presented a number and asked to give the place value to which he wants the number rounded (hundredths, tenths, etc.) Each iteration of the game shows him the number, rounded as he has specified. Each game is designed to illustrate rules for one of the following: (1) rounding where the decision digit is >5; (2) rounding where the decision digit is < 5; (3) rounding where the decision digit = 5; (4) how to handle trailing zeros when rounding. After each game interaction, the student is asked questions which build up to a generalized statement of the rounding rules. Finally, the criterion items require the student to apply these rules in rounding decimal numbers to specified place values.

Design: The strategy of the lesson guides the student linearly through introductory frames, game interactions illustrating the primary rules, questions to draw out rule generalizations, and application of the rules. The student receives a summary of his performance over nine criterion rounding problems. For cases where he has trouble, a reiteration of the appropriate rule is given. If he misses four or more problems, he is looped back for review beginning about midway in the lesson. If criterion performance is still substandard after review, he can opt for more review or another try at the criterion problems before going on to the next lesson.

- DEC3, DEC32 -- Basic Decimal Operations
  DEC3 -- TAIS 3003--Whole Number Arithmetic
  DEC32 -- TAIS 3003--Decimal Arithmetic

  Content: Lesson DEC3 introduces the learning goals as building skill, accuracy, and speed in decimal arithmetic--addition, sub-

traction, multiplication, and division. The enabling and criterion items, instructional frames, and numeric drill for decimals are contained in lesson DEC32. Because whole number arithmetic skills are an assumed prerequisite, lesson DEC3 serves a remedial role in allowing less confident students to gain (or regain) skills with whole number arithmetic before going on to decimal arithmetic. DEC3 provides diagnostic testing, numeric drill, and instruction in how to check whole number arithmetic.

Lesson DEC32 is organized into similar sections as the whole numbers lesson, but with more depth of instructional coverage, more examples, and more diagnostic testing and tutorial practice for all types of operations. Successively, the student must show mastery of decimal addition, subtraction, multiplication, and division as described below. If he can evidence mastery on a sample of enabling items, he goes directly to the criterion items and no instruction is given; otherwise, the start point for instruction will depend on the type of operations giving him difficulty.

Design: The amount of time spent in these lessons will depend first on whether whole numbers review is needed and second, on the extent of instruction in whole numbers and in decimals. The decision on whether to spend time on whole numbers in DEC3 depends upon whether the student has prior practice with decimals and, if so, how recently. If he says he has done decimal arithmetic in the past year, he is branched directly to DEC32. If not, he is shown examples of whole number problems in order to determine his level of confidence. If he says "none" of these would give him trouble, he is moved directly to DEC32. If he says that "some" would give him trouble, he is considered cautious and put onto a potentially

faster DEC3 track than the student who indicates pessimism in that "all" would give him trouble. The cautious student is given several whole number test items and, if he passes these, he is sent on to DEC32; if not, he is allowed to choose whole number drill problems to a maximum of three right or five tries for each type of problem. The student can choose to receive drill in vertical or horizontal formats. Whole number drill problems are generated dynamically during lesson execution by drill subroutines in the AI lesson. Cautious students then indicate when they are finished with drill and ready to try the test items again.

The pessimistic student is never tested diagnostically in DEC3--he is sent directly to select from among the four types of drill. Both the cautious and pessimistic students, in electing to move ahead from drill to the test items, are given the opportunity to see instruction for how to check addition, subtraction, multiplication, and division before going on to the whole numbers test. Students who are coming into the test items after drill proceed through the test sequence and on to lesson DEC32; otherwise, substandard performance causes a loop back from the test items into the drill and checking frames. Students on the pessimistic track are given extra instruction in how to divide two whole numbers for an even decimal quotient, before they are moved on into DEC32.

In DEC32, the student is tested with a sample from the pool of enabling test items to see where instruction should begin. Instruction begins from the type of decimal operation where the student first evidences difficulty--addition, subtraction, multiplication, division by a smaller decimal number for an even quotient, or division by a larger decimal number for an even or uneven quotient. Each instructional segment is

followed by drill (student's choice of format for all but division), the problems generated dynamically during lesson execution by drill subroutines in the lesson. The student must get at least three correct in five tries, otherwise he is sent back to the appropriate instruction. Having mastered the drill, the student goes back over the enabling items that led him into instruction and then on to seven criterion test items. The student receives feedback tailored to three levels of performance on the criterion items and is moved on to the next lesson.

- DEC4 -- Solving Decimal Word Problems
  TAIS 3004--Word Problems

  Content: The student is shown a GED-like word problem as a goal and is asked to choose a slow, intermediate, or fast route to the goal. The lesson is divided into three successive content sections, as follows:

  . Explicit instruction on applying five steps to solving word problems. The steps are: (1) read all words for meaning; (2) find all the facts given; (3) find the question asked and answer units expected; (4) decide on the arithmetic operation(s) needed; (5) work the problem, and check and label the answer. Instruction in this section treats each step painstakingly and tutorially through a sample problem.
  . Guided practice in applying the five steps to the solution of four sample problems, each requiring different operations.
  . Three criterion word problems incorporating minimal guidance.

  Students choosing the explicit instruction route receive in-depth instruction for each of the five steps, ending with a review of the steps, and then go on to the guided practice and criterion items.

Design: The student elects to start the lesson from any one of the three points noted above, based solely upon confidence in his abilities with respect to the word problem presented as a tangible goal. The amount of time committed to this lesson will, therefore, depend substantially upon this initial choice.

If he feels confident, he will elect to try the three criterion word problems. At a midlevel of confidence, he will undergo tutorial instruction on a sample of problems similar in operations required to the set of criterion problems. The least confident students will end up traversing the entire linear sequence of frames, including special help sequences, as required.

The lesson adjusts to the student's performance on the criterion problems, depending upon how he started. If his performance is to standard, he is commended and asked to sign off of decimals irregardless of his track. If he was on the fast or intermediate tracks and his performance is below standard, he receives appropriate performance feedback and udergoes instruction on the next slower track. If he was on the slowest track, the next move is selected from a menu by the student: review options beginning about midway in the lesson, try the criterion problems again, or end the decimals lessons.

b. Percent Unit

- PERC1 -- Equivalence of Fractions, Decimals, and Percent
  TAIS 3005--Numeric Equivalency

  Content: After an overview of the goals of lessons in the percent unit, this lesson tutors students on equivalent ways to express the same value by converting words and fractions to decimals and percent. First, the meaning of the percent symbol is given and the student is shown how a number of "hundredths"

can be expressed in words, as a fraction, as a decimal, and as a percent. The utility of using percent as a common basis for comparison is highlighted through an exercise where the student attempts to arrange scrambled decimal numbers into ascending order of magnitude. After this, the student must select in which life examples it would or would not be appropriate to use percent. Next, the student is tutored on how to convert decimals to percent, and vice versa. After practice exercises, he is taught how to convert fractions and mixed numbers to decimals and percent; first, by rewriting the fraction as a base-100 fraction and, second, by long division when the base of the fraction is not a factor of 100. Before the criterion exercise, the student is given a list of fractions, English phrases, decimals, and percents, and is asked to match these to an equivalent number as it appears. The criterion exercise requires the student to convert five commonly used fractions and mixed numbers to their decimal and percent equivalents.

Design: The style is expository and tutorial, with linear progression through each of the conversion topics: decimal to percent, percent to decimal, and mixed fractions to decimal or percent. For each of these topics a conversion rule and worked examples are given, the student answers questions which restate the rule, and he is tutored through practice problems. Each of these conversion topics ends with a review loop for students whose performance is below standard on the enabling objectives. At the end of a matching exercise on numeric equivalents, the student with substandard performance chooses from four types of review or going on to the criterion exercise. Students who miss three or more of the seven criterion conversions are looped back for review on using division to convert fractions

and mixed numbers to decimal and percent before trying the criterion exercise one more time.

- PERC2 -- Basic Operations in Percent Work Problems
  TAIS 3006--Basic Operations

  Content: The student is presented two word problems which illustrate the two basic types of operations covered by this lesson: (1) to find a given percent of a number, and (2) to find what percent one number is of another. The student is taken step-by-step through the first type of word problem using the five steps to problem solving introduced in DEC4, the lesson on decimal word problems. Next, the rule for finding a percent of a number is stated and the student is given numeric problems of the form "find X% of Y" for computational practice. Finally, he is shown the general sentence syntax for this type of word problem and is tutored through working a word problem of this type. Then, he tries the criterion word problem.

  For the next topic, asking what percent one number is of another, the student is shown that this is comparing two values--comparing a part to a whole--the "is" portion of the sentence to the "of" portion of the sentence. The analogy is made that comparing part to whole means division--divide part by whole, or divide "is..." by "of...". The student is tutored in a sample word problem to give the numbers that should be divided and in the computational steps for working the problem. Then steps of the computational rule are restated and the student works numeric problems of the form "what % is X of Y?". Finally, the student is shown the general syntax form of this type of word problem, is tutored through a practice word problem, and tries the criterion word problem.

Design: The student is stepped linearly through the sequence noted above. For substandard performance on numeric practice problems of the first type, the student is recycled back through instruction and practice once before going on to the practice word problem of this type. Substandard performance on the criterion problem causes the student to be cycled back for review, unless he has already seen the review material. If so, the student selects from another try at the criterion problem, trying both practice and criterion problems, or moving ahead. Students who get the criterion problem right are given the option of trying a more difficult word problem of this type before moving on.

For the second type of problem, the student who cannot pick the right numbers to divide or who divides incorrectly is tutored through two more word problems before moving into further computational practice. Substandard performance on numeric practice problems causes one review cycle. If the student has trouble with the criterion word problem, he chooses among full review, trying the practice and criterion word problems again, or moving ahead.

For either of these problem types, the student who cannot correctly perform the requisite computational steps of multiplying or dividing is asked to choose among several remedial options; one of these choices loops back to portions of lesson DEC32 for instruction and practice in multiplying or dividing decimals, as appropriate.

- PERC3 -- Solving Percent Word Problems
  TAIS 3007--Solving Word Problems

  Content: This lesson builds upon the five steps for solving word problems introduced in the decimals word problem lesson, DEC32. Overlayed onto this is the concept of structure in a percent word

problem, such that problem components are a total value, part value(s), and percent. The student's attention is focused on finding which of these components are missing and which are given in percent word problems. The lesson then steps the student tutorially through finding the facts, the missing component, and working a sequence of percent word problems. This sequence of word problems builds as follows: finding a part value from percent of total and total value; finding a total from a part value and percent increase (or decrease) with respect to that part; finding a part value from a total and percent of total for each of the other parts; finding percent profit (or loss) from buying and selling prices; finding percent of a part from the total and the value of the other part; finding total price from a reduced price and percent discount; and, finding pretax price from a taxed price and percent taxation.

Design: Substandard performance on each type of enabling problem causes at least one review loop before moving on to the next type of problem. Several remedial sequences are also activated under certain conditions. Substandard performance on the four criterion word problems results in selective review, according to the type of problem missed, and then another try. The student who gets all criterion problems right is given the option to try more difficult word problems involving multiple steps in solving for pretax price or a partial distance.

Two of the word problems in this lesson are tailored in accordance with numeric data given by the student. In one, the student is asked for his weight. The lesson then builds a word problem with this data wherein the student must find how much he will weigh given a 10% weight increase. Another

problem asks the student his monthly earnings and, from this, gives a word problem stating monthly wages and the percent for each of several deductions. The student must compute his take-home pay. Subroutines in the AI lesson compute the tailored portions of these problems and the correct answer, against which the student's answer is matched. This lesson also contains many presentation loops to keep each word problem on the screen while presenting a series of questions about the problem.

c. Interpreting Data Unit

- DATA -- Reading Graphs and Computing an Average
  TAIS 3009--Reading Graphs
  TAIS 3010--Computing an Average

  Content: The two parts of the lesson--reading graphs and computing an average--are stated, and the student's learning goals are organized. The lesson determines if the student has the offline support materials (Figures 2-8 and 2-9). Using a bar graph (Figure 2-8), the student is given tutorial instruction and practice questions on information shown by the title, the scales and scale units at left and bottom, the height of each bar, and the overall shape of the graph. Building upon these skills, the student next uses the line graph (Figure 4-9) to learn to draw conclusions on trends over time. Tutorial practice problems successively cover information on the scales, locating values at the top and bottom and the leftmost and rightmost points of the trend line, and comparing the upward and downward line slopes overall and for given segments of time to derive information. Criterion problems require the student to select conclusions justifiable only from information presented on the graph, and to use a formula to compute rate of change based upon information shown on the graph.

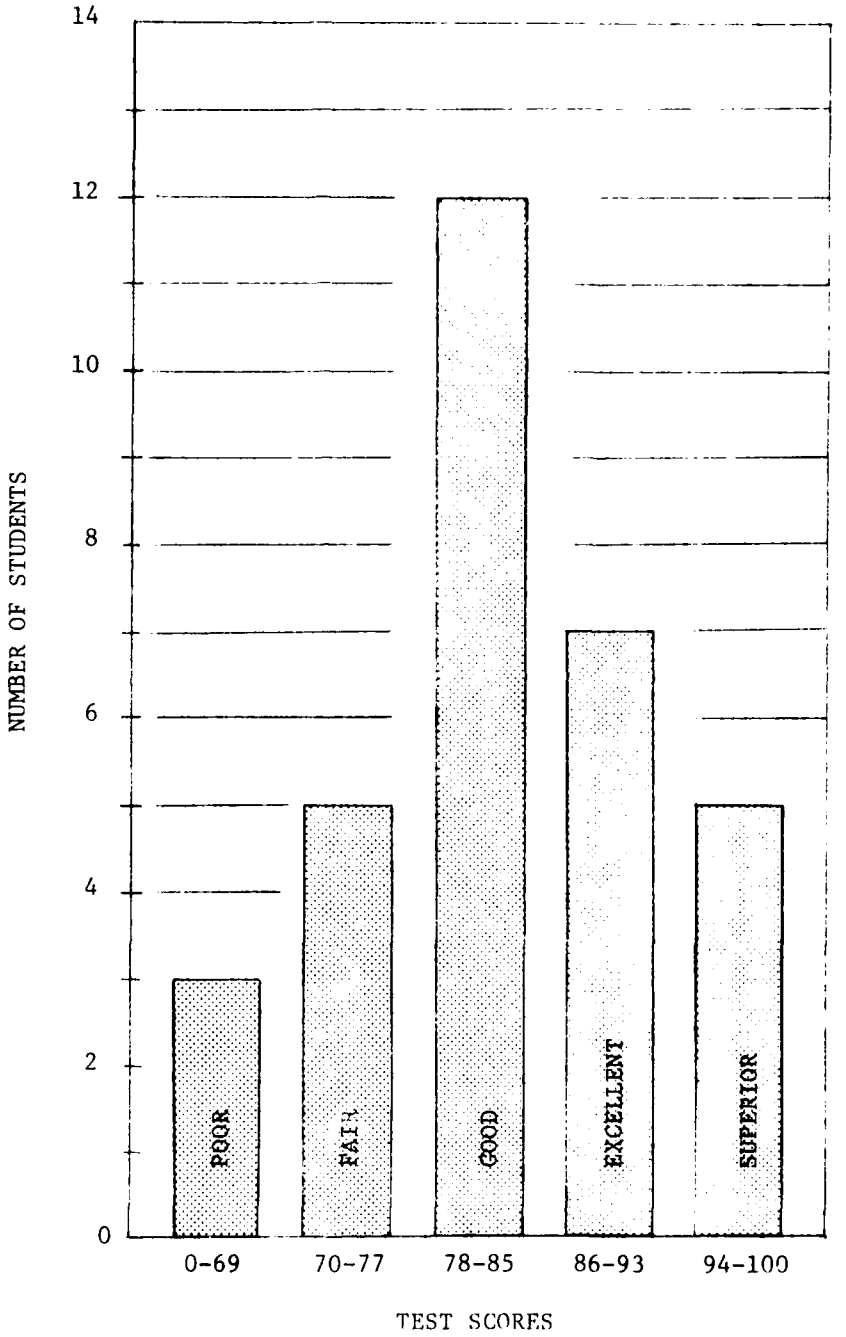


Figure 2-8. Adjunct Exhibit for Bar Graph Topic of GED AI Unit on Interpreting Data

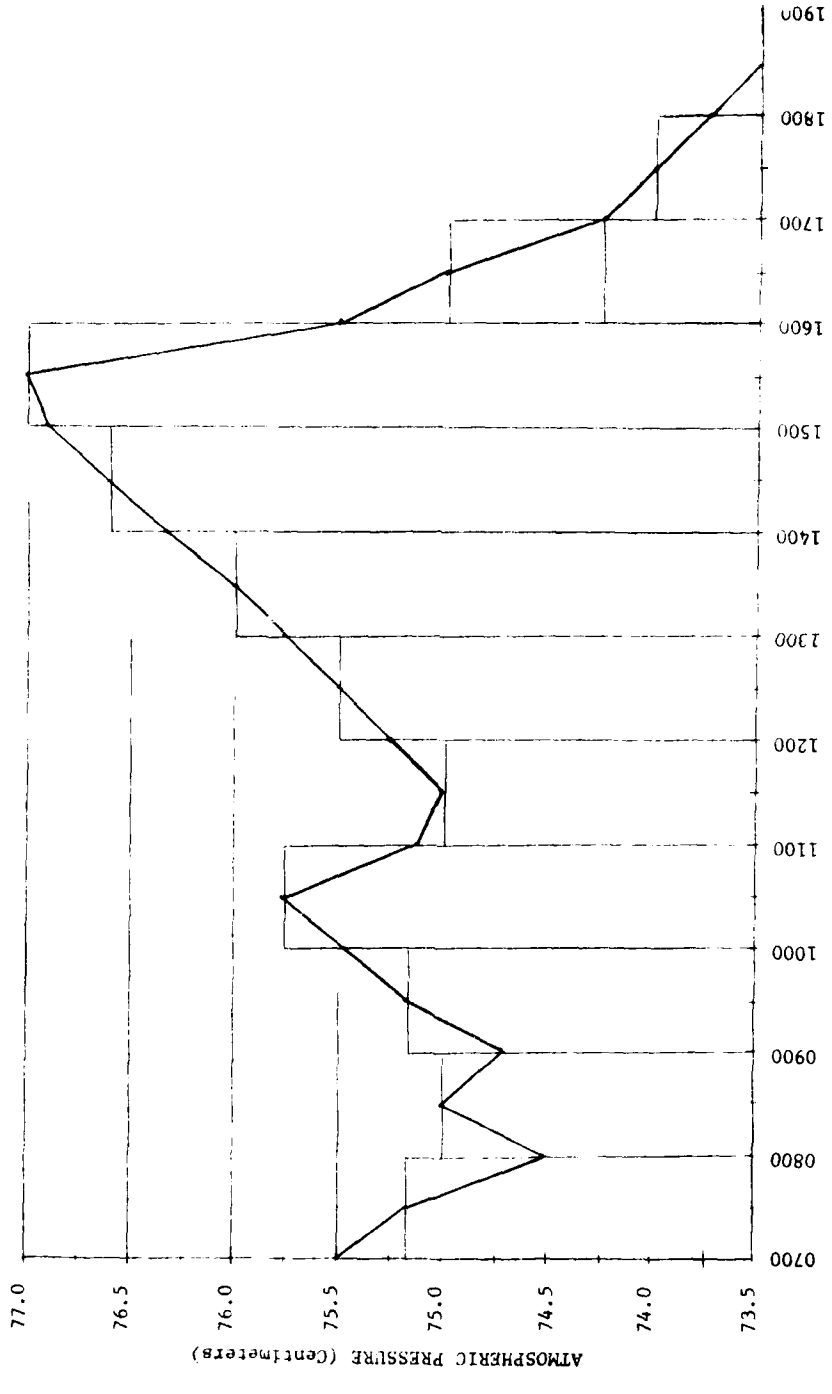


Figure 2-9. Adjunct Exhibit for Line Graphs Topic of GED AI Unit on Interpreting Data

problems in computing the mean of 10 numbers. This subroutine generates the lesson problem data online, and the student gets three tries to get two problems right. If the student fails the criterion item on averages, he is looped back to this drill subroutine if he has not already seen it; otherwise, he is allowed to choose between more drill or trying the criterion problem again.

5. Preparation of Assessment Materials

On-line AI materials for preassessment and postassessment of student performance were prepared. Using the Criterion and Enabling Test Items Worksheets, a list of items was prepared. From this list, two test versions for each GED AI unit were prepared. The test item count by unit and pretest/posttest (version A/B) was as follows:

UNIT	PLANIT NAME	NO. OF ITEMS VERS. A	NO. OF ITEMS VERS. B	NO. OF FRAMES VERS. A	NO. OF FRAMES VERS. B
Decimals	TADEC	32		35	
	TBDEC		32		35
Percent	TAPERC	13		19	
	TBPERC		13		19
Interpreting Data	TADATA	4		9	
	TBDATA		4		9

Pretest and posttest each comprised versions of items appearing in the AI lessons of the corresponding unit. These items were developed as follows, with respect to each other and to comparable items in the AI lessons:

- Decimal and percent word problems were modified with respect to numbers or to the words naming numbers. Names of objects, units, and proper names were also changed (e.g., "bowling team" or "volleyball team," "Sam" or "Joe," etc.). The problem syntax and key words denoting facts, question, and units of measurement were not changed.

In the second part of the lesson, the common notion of average is recalled for the student and he is provided a definition of this as the concept of "mean" average. He is then shown a worked example and receives tutoring in a practice problem. Next, he shows that he can recognize the computational steps by selecting from three descriptions (mean, median, mode) the description for computing a mean. The student then receives practice in applying the component steps of summing unordered data items and dividing by the number of items. Finally, the student computes the mean average of eight unordered data items presented in a word problem.

Design: The basic lesson style is tutorial through a linear sequence of examples and practice problems. This lesson has a higher ratio of multiple-choice to constructed responses than do other lessons for GED AI math. Several remedial help sequences are embedded in the sequence for those students who evidence a need for special help on answering questions based upon the height and distribution of heights of bars on the bar graph. The student is sent through one complete review loop on bar graphs if his answers to criterion problems are below standard; he is taken on to the topic on line graphs after this review and another try at the criterion problems. Students are carefully tutored through all the major line graph objectives.

Examples and problems for the topic on computing an average are straightforward and linear. There is a review loop for the student who cannot select the computational definition for the mean average after seeing a worked example and undertaking a practice problem. Later, if the student cannot apply the computational rule to select the correct multiple-choice answer to a problem, he is given numeric drill

- All constructed response items were changed such that the numeric content was varied; key numbers in the problem and the required numeric answers retained the same number of whole and decimal digits among items, and the same arithmetic operations were needed.
- In several multiple-choice items, the form of numbers in the alternatives remained the same but the numbers were changed, as was the position of the correct answer alternative. In two multiple-choice items, relational words of the stem (rise/drop) or in the answer alternatives (increasing/decreasing) were changed such that the correct answer alternative became different among items.

As with the production of AI lesson materials, the tests were encoded in the PLANIT language and keypunched. Listings were prepared for each test and version, reviewed, and modifications made as required. These test materials were not used for differential initial placement into the AI lessons, nor for diagnostics of other kinds.

6. Delivery of Materials and ARI Technical Review

Completed sets of course and test materials--decks, listings, and adjunct materials--were shipped to ARI in June and July. ARI converted the card decks into the character set required for use at the test facility at Fort Hood, Texas. As a backup, a set of course materials was also sent to Fort Hood.

During July, ARI conducted an on-line check of lessons DEC1, DEC2 and DEC3. Telephone communications in July indicated that these runs were uncovering problems with numeric answer-matching and decision statements based upon cumulative lesson records; it could not be determined that the problems were in the AI software or the courseware. During the first week of August, Major Ken Fearing, a mathematics teacher and Army reserve consultant for ARI, conducted an extensive content review of the GED AI lessons. Working closely with the SDC lesson author, Major Fearing conducted a page-by-page review of the five lesson listings for the GED AI decimals unit and made working notes for

frame revisions, additions, and deletions. The major portion of the changes suggested was to serve the following purposes: (1) making instructions to students more explicit; (2) clarifying content passages or examples; and (3) filling gaps with transitionary content. ARI staff personnel also tried lessons DEC1 and DEC2 during the SDC author's presence at ARI. These on-line tryouts served to suggest changes needed both to the AI software and to the courseware.

Some of the changes resulting from this technical review were incorporated into DEC1 and DEC2 by the SDC author using PLANIT in the on-line edit mode at ARI. The remaining suggestions for DEC3, DEC32, and DEC4 were incorporated via keypunch or on-line edit after arrival at Fort Hood, Texas early in August. The decision was made during this work to use the GED AI decimals unit as the lesson materials for the Fort Hood AI field experiment.

Section 3: CONDUCT OF THE FIELD TEST

A. PRELIMINARY ACTIVITIES

1. Identification and Selection of the Subject Pool

The study was directed toward 11B40 personnel. The problem was to both identify 11B40 personnel and determine those who would need or benefit by MOS training in crew served weapons or tactics or in GED mathematics. The approach used was to obtain the personnel data on 11B40 personnel from the PA6 tapes covering the 2nd Armored Division and 1st Cavalry Division at Fort Hood, Texas. Listings of summary data were prepared and card decks containing identifying information were punched from the tapes. These card decks were sent to the Enlisted Evaluation Center, Fort Benjamin, Harrison, Indiana to obtain the 1972 MOS proficiency test scores. Updated listings (Figure 3-1) and card decks were then prepared.

In August 1973, a month prior to the start of MASSTER Test 122, the card decks were run against the SIDPERS personnel system (which replaced the PA6 system at Fort Hood). Two critical pieces of information regarding the listed 11B40 personnel were obtained from this run: (1) whether they were still at Fort Hood; and (2) their current education levels. On the basis of this information, listings (Figure 3-1) of the subject pool were prepared and delivered to Headquarters MASSTER.

Those with GT scores below 88 (8th Grade Level is 90) were eliminated. Frequency distributions were plotted of 1972 MOS Proficiency Test Scores. An upper and lower cut-off score on the total test of 79 and 40 (score of 31 on the 125-item, multiple-choice MOS Proficiency Test is chance) was established for inclusion in the sample population. These cut-off scores represented breakpoints on the distribution where the curve showed a marked change. In the 2nd Armored Division, approximately 4% of the lower end of the distribution and approximately 15% of the upper end of the distribution were eliminated by this process.

SSN	NAME	P/C	DTCS	ED	VERBAL	ARITHMETIC	GT	1	2	3	4	TOT
58[illegible]0	[illegible]RIGUEZSAN [illegible] V	E06	11B40	C			GT-097	11	11	12	19	[illegible]
35534[illegible]379	ROG[illegible] BER[illegible]	E06		B			GT-089					
544647[illegible]	ROGERS RONALD W	E04	11B40	F			GT-[illegible]					
560 5422[illegible]	ROJAS PEDRO	E05	11B40	F			GT-091	14	17	16	[illegible]	[illegible]
401463937	RORER EVERETT L	E06										
21306718	ROUSSEAU RICHARD EDWAR	E04	11B40	F			GT-11[illegible]					
462703003	ROY FRANCIS LLOYD	E05	11B40	B	VE-1B-103	AR-3B-104	GT-103	13	11	13	27	6[illegible]
465764171	RUBALCAVA RUBEN	E05	11B40	[illegible]			GT-[illegible]	12	09	15	20	56
10040 662	RUDOLPH PATRICK J	E05	11B40	N			GT-146					
557604361	RUGE JERRY WAYNE	E05	11B40	C	VE-C -080	AR-Q -060	GT-074	15	15	14	22	66
383465121	RUSH HORACE E	E06	11B40	E			GT-114	10	16	19	22	67
454547660	SALINAS MANUEL PERALES	E07	11B40	F			GT-101	14	20	19	32	85
27522 554	SAMS LEE JUNIOR JR	E06	11B40	E	VE-1B-135	AR-3B-131	GT-132	17	20	19	26	[illegible]
452744149	SANDEFER THOMAS HENRY	E05	11B40	A				13	14	13	19	59
436824632	SANDERS CHARLIE	E05	11B40	B			GT-790					
457668756	SANDERS TEDDY DOYLE	E05	97020	E	VE-2B-128	AR-4B-110	GT-122	12	10	13	20	55
326443283	SANDERS WILLIAM EDWARD	E05	11B40	E	VE-2B-084	AR-4B-084	GT-084	13	16	12	19	60
457762675	SANMIGUEL JUAN	E05	11B40	A	VE-8Q-068	AR-8Q-080	GT-088	08	11	18	18	55
58347193	SASIAIN ESTEBAN	E06		E			GT-088	10	17	15	17	59
378488335	SCHINDLER GARY EDWIN	E05		B			GT-060					
254663518	SCOTT HERBERT CARLTON	E05	11B40	F		AR-3B-079	GT-112	25	22	20	31	98
438728463	SCOTT LEROY	E05		E	VE-1B-078	AR-3B-086	GT-082	09	13	16	19	57
494543214	SCOTT TERRY LYNN	E05	11B40	J	VE-1B-109	AR-3B-107	GT-108					
248701905	SCRIVEN JOSEPH	E05	11B40	E			GT-082	08	09	12	16	45
250781344	SEARS WILLIAM FORREST	E06	11B40	E	VE-7Q-100	AR-7Q-105	GT-103					
229646450	SELL EDWIN T	E05	11B40	C			GT-095					
436523699	SEYMORE DANIEL ALBERT	E06	11B40	E			GT-086	10	17	18	26	71
255569637	SHARPE THEODIS	E05		F			GT-086					
257782710	SHAVERS HENRY JR	E05	11C40	E	VE-7Q-062	AR-7Q-074	GT-068	11	16	10	17	54
308445554	SHAW RAYMOND ALBERT	E06	11B40	E	VE-8Q-084	AR-8Q-068	GT-076	12	16	11	22	61
494444476	SHEPARD JOHN E	E06	17K40	F	VE-2B-084	AR-4B-089	GT-087	11	15	20	20	66
230741727	SHEPPARD MILLARD LEE	E05	11B40	F	VE-7Q-097	AR-7Q-093	GT-099	08	12	12	17	49
403745174	SHUMATE JIMMY TAYLOR	E05	11B40	B	VE-1B-111	AR-3B-101	GT-106					
411528175	SHYES JOHNNY B	E07		E			GT-101	14	18	24	20	76
407665442	SIDEBOTTOM LARRY ROSS	E05	11B40	E	VE-8Q-071	AR-8Q-090	GT-081					
586 5 1	SIGUENZA THOMAS B	E05	11B40					08	10	06	10	34
115362898	SIMMONS JAMES EDWARD	E05	11B40	E			GT-113	13	12	18	25	68
478589508	SIMMONS TERRY P	E05	11B40	E			GT-109	16	15	18	19	68
224542027	SIMPSON WILLIAM MARTIN	E05	11B20	7	VE-2B-065	AR-4B-084	GT-075					
439688173	SMELSER JOHN DAVID	E05	11B40	F	VE-1B-130	AR-3B-129	GT-130	19	15	16	27	77
200264084	SMITH CLEMENT EUGENE	E07	11B40	E			GT-109	13	20	19	27	79
495548873	SMITH DANIEL R	E05	11B40	E			GT-074					
454807324	SMITH JOE D	E06	11B40	E			GT-119	17	16	19	25	77
452747536	SMITH WILLIAM DANIEL	E05	11B40	E	VE-7Q-118	AR-7Q-093	GT-106	17	21	21	25	84
228661777	SMITH WILLIAM ODELL JR	E05	11B40	E	VE-1B-084	AR-3B-086	GT-085					
461769392	SOZA JESSE CASTILLO	E05	11B40	K			GT-125					
242845371	SPEIGHT AMOS RUDOLPH	E06	11B40	E	VE- Q-086	AR- Q-087	GT-087	13	11	10	16	50
252842802	SPILLERS GARY WAYNE	E05	71H30	E	VE-1B-152	AR-3B-116	GT-134					
461649082	STANLEY JIMMIE ROYCE	E06	11B40	F			GT-097	14	16	23	31	84
416603973	STAPLES JOE NATHAN	E05	11B40	F			GT-087	16	12	14	24	66

Figure 3-1. Sample of Subject Pool Listings

The above process provided a pool of 11B40 subjects for whom training was needed and whose education level (8th grade or higher) indicated attainment of the minimum reading skills required for this training medium.

Preliminary analysis of the 11B40 subject pool indicated that a substantial number of 11B40 personnel had neither obtained their high school diploma nor met the GED high school equivalency requirements. However, experience with 11B40 personnel during the first 3 weeks of MASSTER Test 122 showed that almost all of those selected from the pool for the test had now met the GED requirements (only four had not, one of whom had scored very high on the pretest).

Consequently, a subsequent list of Army personnel with GT scores of 78 and above and an education level of 7th, 8th and 9th grade was developed. All of the GED subjects except three came from this list. Most of these subjects were Privates or PFCs, were considerably younger than the 11B40s, and had lower GT scores than the 11B40s.

There is a probable tendency on the part of the Army to volunteer subjects who are least important to the operation of the unit or organization. This probably would have resulted in the subject pool for this study being more representative of nonkey personnel in the organization, i.e., personnel at the lower end of the distribution. Therefore, by identifying the subject pool in advance, it was felt that a better quality of participating subjects would be ensured than were the organization free to send whomever it pleased. An example of this occurred when one of the GED subjects turned out to have 2 years of college, was not on the selection list, and had been sent to fulfill the required number of "bodies" for that particular day.

2. Computer Checkout of Course Materials

Prior to the field test, 10 subjects were obtained for a period of 5 workdays for course checkout. These subjects comprised 11B40, 11B20, 11B10 and other personnel. Because of system problems, the arrival and use of these personnel

were delayed until Wednesday, 22 August 1973. Throughout the remainder of the week a variety of system problems, e.g., not enough storage for student records, caused computer breakdown or many restarts, which negated the effective use of these subjects. On Monday and Tuesday, 27 and 28 August, although system performance improved, many problems still existed, e.g., unreliable subsystems communications. An attempt was made to increase the availability period of the 10 subjects in question, but this was denied by the unit concerned.

SDC, ARI, TSDG and BRC personnel continued to check out the system and course materials throughout the week, and by 31 August the system was considered reliable enough to start MASSTER Test 122 on schedule.

Despite the limited opportunity for using personnel for tryout, many valuable insights were obtained into 11B40 personnel requirements for taking the courses. For example, one major effort involved updating the courseware to provide additional specific cues indicating that a response was required and the form of that response (e.g., on a multiple-choice question, select a letter). Based on experience with the 10 subjects, a second major effort was to incorporate additional anticipated incorrect responses into the course materials and to provide specific feedback on why they were wrong.

In addition, it became apparent that on-line pretesting and posttesting of subjects during the experiment would be impractical, as the average student test execution time was 30 to 40 minutes. This would have reduced the available on-line computer time for AI to approximately 3 hours, which was in conflict with the 4 hours allocated for the Study and Control Groups. A decision was made to create paper and pencil tests, designated Versions A and B, for each group, i.e., AI, Study and Control. These tests contained the same test items as those incorporated in the on-line pretests and posttests described in Section 2. (These tests are available at the U.S. Army Research Institute or SDC.) Student execution time as measured by this checkout also gave indications as to the amount of AI materials that could be executed by "average"

students during 4 hours of on-line time. Based upon these execution time estimates, the structure for the AI courses to be used in the field experiment was finalized as follows.

CSW	TACTICS	GED
LAW1	INDIV1 (1)	DEC1
LAW2	INDIV3	DEC2
LAW3	SQUAD1 (2)	DEC3
LAW4	SQUAD2	DEC32
	SQUAD21	DEC4
	SQUAD3	
	SQUAD31	

A short introductory lesson called INTRO was also developed which showed the types of questions being asked in the courses and the various methods of responding. Refer to Appendix C for a listing of lesson INTRO.

The net effects of these changes were to make the mechanics of taking the courses simpler for 11B40 personnel so that they could concentrate on the learning process without the frustrations entailed in not knowing how to communicate with the computer.

B. CONDUCT OF THE EXPERIMENT

1. Experimental Design

The experimental design for each of the two MOS portions and the GED portion of this study is shown in Table 3-1.

(1) The topic "Challenge and Password" in this lesson was not used during the experiment.

(2) Instruction in the lesson concerning "Review of the Organization of a Combat Rifle Squad" was not used during the experiment.

TABLE 3-1. EXPERIMENTAL DESIGN

PRESELECTION	PRETEST	RANDOM SELECTION OF GROUPS	TRAINING	POST-TEST	INTERVIEW
MOS: 11B40 personnel who are relatively low on MOS Proficiency Subtest for either Crew Served Weapons or Tactics; GT score of at least 88 (slightly below 8th Grade Level of 90).	Low to Middle Range on Pretest	AI n = 30 C n = 15 S n = 15	AI Training No Training Study Training	Yes Yes Yes	Yes No No
GED:* 11B40 personnel who have not graduated from high school or met high school equivalency requirements; minimum GT score of 88.	Low to Middle Range on Pretest	AI n = 30 C n = 15 S n = 15	AI Training No Training Study Training	Yes Yes Yes	Yes No No

*Apparently Fort Hood has an extensive GED program and many of the 11B40 personnel who were expected to be part of the GED portion of the study had already met their high school equivalency requirements. Therefore, the preselection criteria on GED was modified during the course of the study to include any Army personnel who had a GT score at or above 78 (slightly below the dull normal level of 80) and an education level of 7th grade or above.

The AI Group of 30 and the Control and Study Groups of 15 each were selected to provide the minimum number of subjects required to: (1) thoroughly sample learner characteristics and reactions to the system; (2) show not only statistically significant differences, should they occur, but also a substantial supportive set of practical differences; (3) provide some stability to the analysis of results by reducing the chance effect of one or two individuals who may deviate markedly from the performance of the group as a whole.

While further increases in this minimum sample size would have been desirable from a statistical viewpoint, a balance had to be maintained between computer console availability and total experimental requirements. The above sample size was considered a good compromise between the two.

2. Initial Planning

The agencies involved in the planning and conduct of the field test were:

U.S. Army Research Institute, Washington, D.C.

U.S. Army Research Institute Field Unit, Fort Hood, Texas

Tactical System Development Group (TSDG), CSC, Fort Hood, Texas

ARTADS Field Unit, Fort Hood, Texas

Headquarters MASSTER, Fort Hood, Texas

System Development Corporation, Santa Monica, Calif.

Planning activities centered around the following areas:

Computer Operation

Personnel Support

Physical Facilities

Test Subjects

Test Monitors

Test Logistics - transportation of students, messing, latrines, etc.

a. Computer Operation

The DEVTOS computer facility is a tactical system comprising a CDC 3300 central computer and four CDC 1700 computer RSDTs (Remote Station Data Terminals), each connected to five UIODs (User Input/Output Device). Both the central and remote computers have cryptology equipment attached which encodes and decodes the messages transmitted. Each UIOD comprises a display station (CRT and keyboard) and an IBM selectric typewriter for hardcopy output. For the purposes of this study, only the display station was used and the typewriters were "capped" with their field covers.

The central computer, each RSDT and the 20 UIOD CRTs are housed in separate vans. (Figure 3-2 depicts the central computer.) Communication between the vans is by a voice "squawk box." Whenever the TOSSOC (Tactical Operations System Sector Operations Center), a double van which houses the 20 UIODs, is used, a crypto operator is required to be in attendance when the crypto equipment is in use. Use of the crypto equipment increased the communication time for transmitting and receiving messages and increased the difficulty of resolving problems regarding the communication hardware and software interfaces of the system.

ARI had responsibility for the PLANIT installation, including reprogramming of the central computer and system checkout. TSDG (assisted by BRC) was responsible for interfacing the CDC 1700 to accept PLANIT inputs and outputs and for operation of the system. SDC was responsible for computer on-line checkout of the courseware. Several factors served to further confound the situation: the PLANIT AI System was still in the developmental stage during the July-August 1973 time period; the RSDT hardware and communications interface software had never been run continuously over a prolonged time period and its reliability was therefore in question, especially with regard to the effect of the number of users (students) and with regard to the I/O characteristics of AI messages (heavy output loads with highly variable input loads); and the effects of running PLANIT courseware and maintaining student records on the system over a long period of time were unknown. Each of the organizations involved required

Figure 3-2. Tactical Computer Van, Computer Operator Console

good system analysis and careful allocation of available computer time, especially since the activities of all three agencies were taking place during the August time frame. Complete checkout of course materials could not take place until the various parts of the system and their interfaces were made operational. Unique to this situation was the use of course materials to check out the various CAI and computer software programs and their interfaces.

b. Personnel Support

ARI and TSDG personnel assigned to MASSTER Test 122 included computer operators, crypto personnel, RSDT personnel, TOSSOC personnel, computer programmers (including Bunker Ramo personnel assigned to TSDG), system analysts, TSDC project officers, appropriate support personnel, and ARI scientists. SDC project personnel completed the test team.

c. Physical Facilities

Physical facilities were carefully reviewed. TSDG has only one classroom, used periodically for briefings and other activities. Moreover, this limited space is at the end of a 1/4-mile tunnel, which meant a minimum travel time of 15 minutes each way. The use of Portavans placed adjacent to the TOSSOC was considered a better solution. Three Portavans were obtained--complete with lighting, heating and air conditioning--and located adjacent to the TOSSOC. Field tables and folding chairs were then acquired for use within each Portavan.

These Portavans were used for the pretests, Study and Control Group activities, posttests, and interviewing. They provided for fairly close control of subject activity, minimized the time lost going from one phase of the field test to another, and resulted in a reduction of the number of test monitors required. Telephone communication between the Portavans and TOSSOC facilitated the smooth scheduling of test subjects into the various test phases within each day's activities.

d. Test Subjects

Test subjects were 11B40 personnel, Light Weapons Infantryman, except for variations occurring in order to obtain sufficient subjects for the GED pool. A rigid paper control was established on personnel in the subject pool. Lists of eligible personnel in the pool were furnished to Headquarters MASSTER and checks made to ensure that these personnel were the ones reporting as test subjects. One of the unknowns was how 11B40 personnel would treat the CRTs in the TOSSOC. A short preliminary instruction sheet was prepared to facilitate getting on the computer and a short introductory lesson, INTRO, developed to provide subjects with experience in interacting with the computer. Procedures for handling the subjects through the various phases of test activities were developed to ensure that their time was fully occupied in test activities.

The waiting period between the pretest and assignment to AI, Study or Control Groups was designated as a coffee break, which also provided time for subjects to peruse personal data on the test record sheet in their test folder. This folder was retained by the subject during the day's activities and showed his progress through various phases of the test. This served as a control measure in that it identified the subject to the test personnel who, by looking at the test record sheet, could determine if the subject was in the right place and if he was working on the correct activity, e.g., Version B of the posttest.

e. Test Monitors

The test monitors were four NCOs, paygrade E4, who were trained to administer and score the pretest and posttest, conduct the Control Group activities, and monitor the Study Group. During their training process, they took the tests, took portions of the AI courses, and generally served as a checkout group for the procedures used. Some consideration was given to the possible situation of E4 personnel monitoring the activities of higher ranking NCO test subjects, but this was not felt to be a potential problem area.

f. Test Logistics

Test logistics involved: (1) transporting the test subjects from Fort Hood, main post to the test area at West Fort Hood and return; (2) messing facilities for the noon meal; and (3) toilet facilities during the day. Arrangements were made for an Army bus to deliver the students each morning and to return the students in the afternoon upon completion of test activities. Coffee and water were provided to the test subjects throughout the day. The noon meal was provided primarily by the Post Exchange food truck on its regular run to the TSDG area; the appearance of the truck signaled the noon lunch break. At the morning briefing, subjects were offered the option of eating at the mess hall at West Fort Hood. Those few who accepted the offer were transported to the mess area by private car, driven primarily by test monitor personnel. Toilet facilities comprised two portable latrines located behind the Portavans.

3. Training of Monitors

Four NCO monitors from the 163rd M.I. Battalion (C) at West Fort Hood were used throughout the study. These were Sgts. Crane, Rains, Shaw and Skrine. They arrived, as scheduled, on 4 September 1973 and were briefed on the purpose of MASSTER Test 122 and the procedures to be used. The monitors were then used to test out the procedures. They filled out the Introductory Form, the Test Data Questionnaire, took the LAW pretest, and went on-line with the LAW course.

On 5 September, specific monitor assignments were made and the procedures-introductory form, initial briefing, pretest, scoring, assignment to groups, AI Group activities, Study Group activities, Control Group activities, posttest, scoring, interview and release were dry run several times. Instructions for use of all materials, forms, and tests were covered.

4. Physical Layout

MASSTER Test 122 was conducted at West Fort Hood in the TSDG area, which is somewhat removed from other activities conducted at West Fort Hood. The physical layout is depicted in Figures 3-3 and 3-4. As noted previously, three Portavans were obtained for MASSTER Test 122. These had windows, electric lights, air conditioning, electric heating, field desks and folding chairs. Portavans 1 and 2 had telephone hookups into the Fort Hood exchange; long distance calls could be received--but not sent--from these phones. Portavan 2 contained the Alpha Dot communication equipment for the Control Group. Pallets were used to construct walks between Portavans and the parking areas and roads.

Portavan 1, the headquarters van, was used for scoring tests, interviewing subjects, and briefing visitors; Portavan 2 for Control Group activities, test administration, and interviewing subjects; and Portavan 3 for filling out the Introductory Form, briefing on the study, Study Group activities, test administration, and interviewing subjects.

The AI (CAI) Group activities took place in the TOSSOC van (Figure 3-5). AI students were restricted to the guard post and TOSSOC areas.

Two portable latrines were obtained and serviced weekly.

As described in paragraph 2 above, an Army bus provided subject transportation from Fort Hood, usually arriving between 0800 and 0830 hours and returning around 1600 hours. Messing facilities were provided by means of a PX lunch truck, which usually showed up around 11:15 A.M., or by transporting students by private cars to the 163rd M.I. Bn (C) mess hall at West Fort Hood, about 2 miles away.

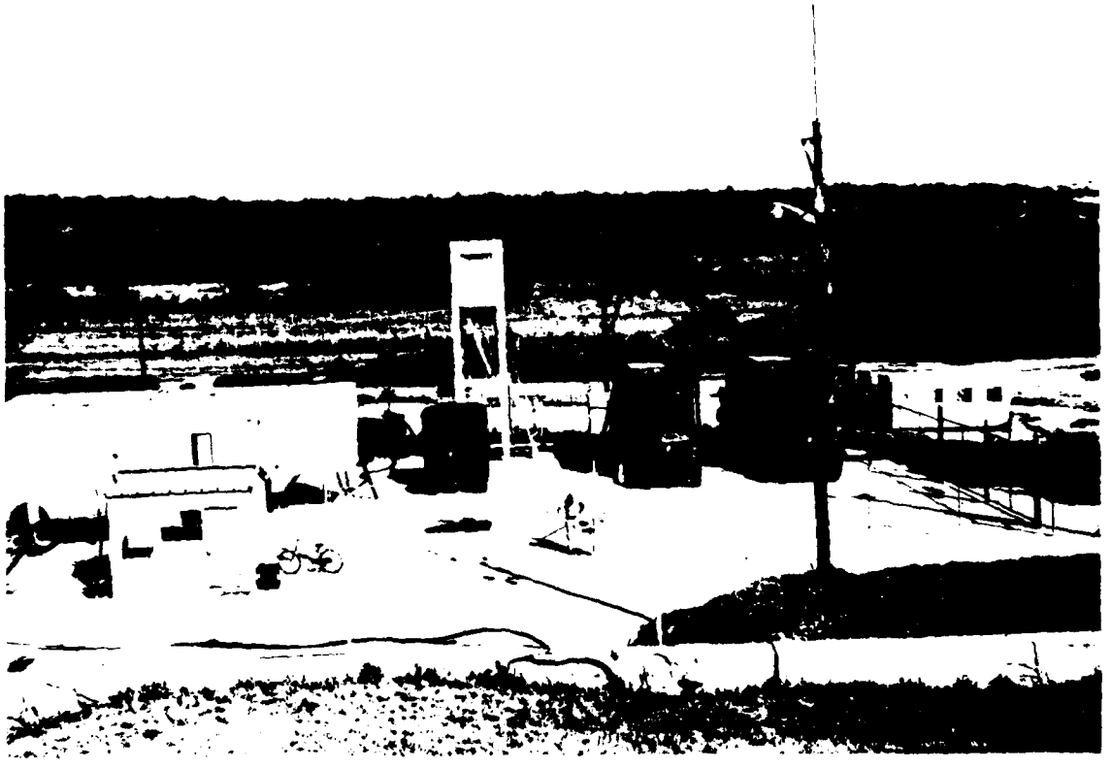


Figure 3-3. Facility Layout for MASSTER Test 122

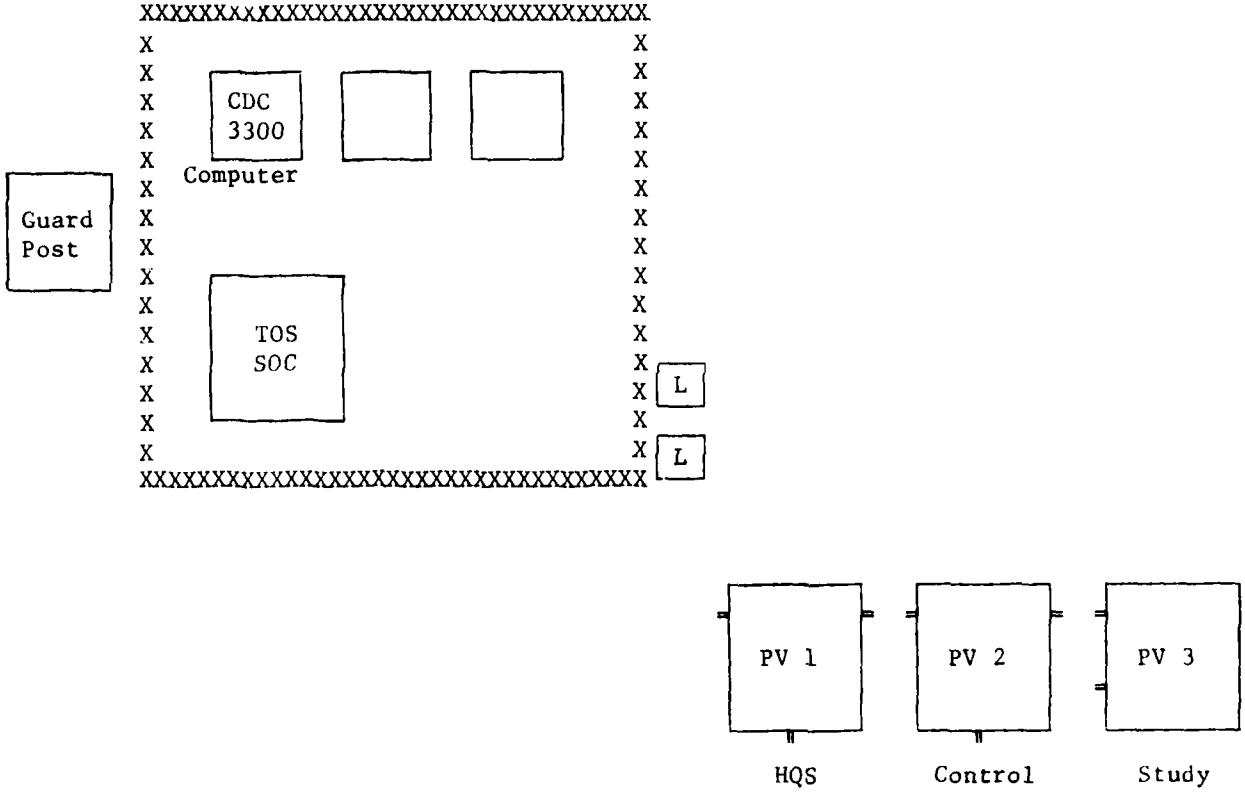


Figure 3-4. Diagram of the Facility Layout for MASSTER Test 122

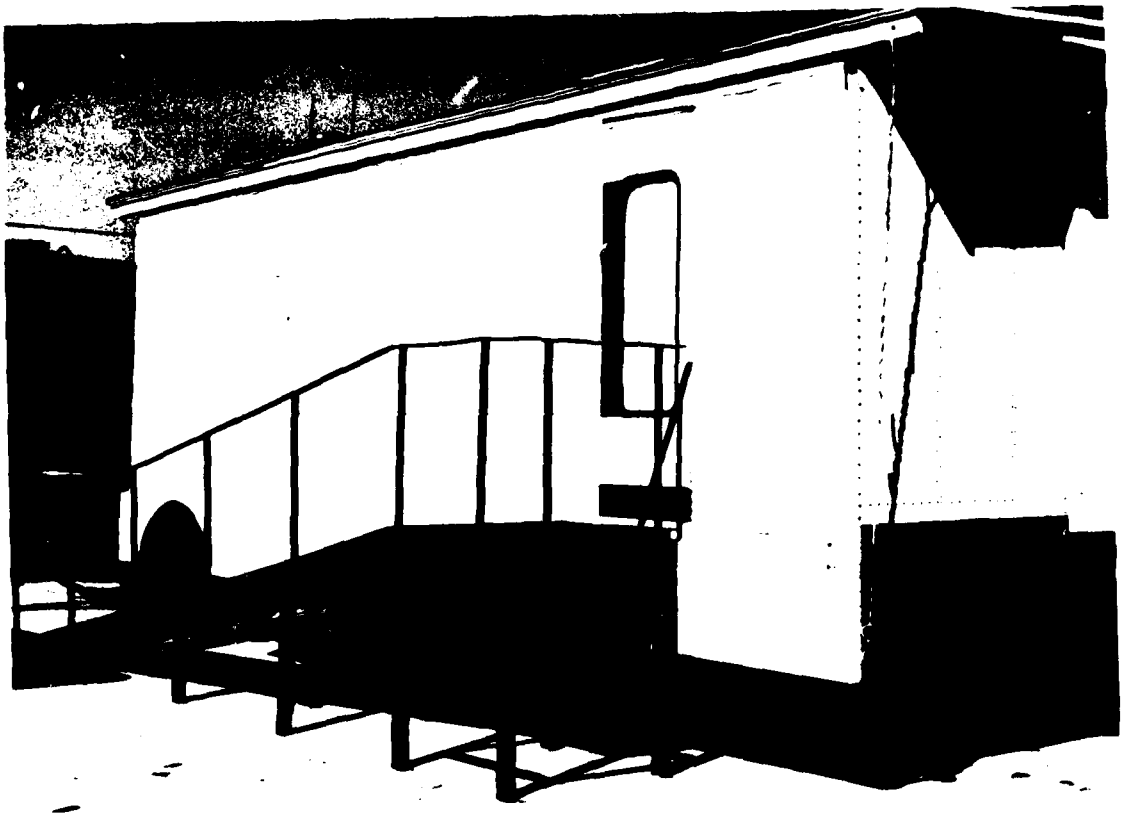


Figure 3-5. TOSSOC Van

5. Procedures

a. Initial Test Assignment: CSW, Tactics or GED Math

Subjects (maximum of 12) were met on arrival and directed to Portavan 3. They were asked to fill out the Introductory Form (Figure 3-6), and were then briefed on the purpose of MASSTER Test 122 (Appendix D contains this orientation briefing). While the briefing was being conducted, student record forms were pulled (Figure 3-7) and assignment made to one of the three subject areas based upon MOS Proficiency Subtest Scores for CSW or Tactics (usually the lower of the two) or, for GED, not having achieved a high school equivalency diploma (as shown on the student form and in the subject's statements on the Introductory Form). The appropriate pretest (half Version A and half Version B) was then pulled and inserted into the subject's manila folder along with the student record form.

b. Pretest

After the briefing, the 12 subjects were divided into two groups, six remaining in Portavan 3, and six going to Portavan 2. The pretests, half Version A and half Version B, were administered at this time. Figure 3-8 shows the instructions provided. Subjects were allowed as much time as they required to take the pretest. For each subject, the monitors noted the start time and end time on the test cover sheet. When finished, subjects were given a coffee break outside the Portavan. Subjects were not told their pretest scores until after the day's activities had been completed.

c. Assignment to Groups: AI, S or C

The pretests were scored (Figure 3-9). Those scoring too high were automatically assigned to an XC Group and treated as other subjects in the Control Group. The remaining subjects were assigned at random to the AI, S and C Groups by pulling a slip of paper from a cup and assigning the subject to the group specified on the slip. One stipulation was that there would be at least five (sometimes four) AI Group members each day in order to maximize use of computer

TEST DATA QUESTIONNAIRE

NAME Juan Sanchez DATE 7 Sept 73

SERVICE NO. (or SS No.) 457-76-2675 RECORDED BY

GRADE E-5 TIME IN GRADE 3 yrs MOS 11C40 AGE 25

JOB TITLE SQ Leader EDUCATION GED
(Grade completed or degree)

UNIT H Co 18th Armd Div/2nd H.C.

Are you in the USAFI GED High School Equivalency Program? Yes ____ No ✓

PHONE NUMBER 685-2936

Figure 3-6. Sample Introductory Form

ID NUMBER: 1. S7762675 2. 3. DATE: 9/7/73

NAME: SANMIGUEL JUAN GRADE: E05 SSAN: 457762675

PRIMARY MOS: 11B4C DUTY MOS: 11B40 RANK: SGT

GT SCORE: 1. 088 2. EDUCATION: A DATE OF BIRTH: 1 OCT 47

MOS 1: 08 UNIT: ADU

MOS 2: 11

MOS 3: 18

MOS 4: 18 PHONE NUMBER:

MOS T: 55

COURSE: CSW TOTAL TIME: START TIME: 0945 1150 1355 END TIME: 1120 1335 1505

MODULE: NUMBER OF FRAMES:

PRE: 11 VER: B TIME: 25 START TIME: 0840 END TIME: 0905

POST: 20 VER: A TIME: 14 START TIME: 1515 END TIME: 1529

GROUP ASSIGNED: (AI) S C MONITOR:

LESSON 1: TIME: NUMBER OF FRAMES: 1. 2.

LESSON 2: TIME: NUMBER OF FRAMES: 1. 2.

LESSON 3: TIME: NUMBER OF FRAMES: 1. 2.

LESSON 4: TIME: NUMBER OF FRAMES: 1. 2.

LESSON 5: TIME: NUMBER OF FRAMES: 1. 2.

INTERVIEW: DATE: START TIME: END TIME: INTERVIEWER:

RECORDS: HARDCOPY: DATE:

TAPE: TAPE NUMBER: DATE:

1.	4.	7.
2.	5.	8.
3.	6.	9.

Figure 3-7. Sample Student Record Form

NAME:_____ DATE:_____

SSAN:_____ START TIME:_____

UNIT:_____ END TIME:_____

_____ 1._____2._____

DECIMALS TEST

VERSION A

INSTRUCTIONS:

1. PLEASE ENTER YOUR NAME, SOCIAL SECURITY NUMBER, UNIT, AND DATE AT THE TOP OF THE PAGE.

2. WAIT FOR THE MONITOR TO TELL YOU WHEN TO START. HE WILL ENTER THE START TIME.

3. LET THE MONITOR KNOW WHEN YOU HAVE FINISHED BY RAISING YOUR HAND. HE WILL ENTER THE END TIME.

4. USE YOUR SCRATCH PAD WHENEVER YOU WANT TO.

5. WORK AT YOUR OWN PACE AND CHECK YOUR ANSWERS AS YOU GO.

WHEN YOU HAVE COMPLETED PUTTING IN YOUR NAME, SSAN NUMBER, UNIT AND DATE, AND ARE READY TO TAKE THE TEST, LET THE MONITOR KNOW BY RAISING YOUR HAND.

Figure 3-8. Sample Pretest Instructions

Figure 3-9. Scoring Tests in Portavan 1

consoles, and this many AI slips were always included in the cup. S and C slips, which constituted the remainder of slips in the cup, matched the number of usable subjects for that particular day, e.g., if 2 subjects out of 11 for a particular day were XC subjects, the cup would contain 9 slips broken down to 5 AI, 2 C, and 2 S slips. Assignment of the 9 subjects to the AI, S and C Groups was on a random basis.

d. Test Period

1. AI Group. The AI Group was signed in and given a security briefing at the guard post, and then taken to the TOSSOC. After assignment to a console (Figure 3-10), students followed the printed instructions (Figure 3-11) and logged in with their student ID number, took the short INTRO lesson to become accustomed to the computer console, and then took their assigned course--Crew Served Weapons, Tactics or GED Math. Subjects remained on console until they had completed their course or the time period (average approximately 4 hours on console for all AI subjects) had elapsed (Figure 3-12). Students logged out for lunch when the PX truck arrived; after lunch, they logged in again and resumed where they had left off. They were free to take coffee or latrine breaks whenever they so desired during the day. Student activities were monitored and logged by the AI Group monitor.

2. Study Group. The Study Group was sent to Portavan 3 (Figure 3-13) and given the instructions and study group materials for their assigned study--Crew Served Weapons, Tactics or GED Math (Appendix E). These Study Group materials covered the same lesson areas as those taken by the AI Group on the computer; however, specific subject matter areas and field manuals or texts giving paragraphs and page numbers to be studied were cited for the Study Group.

Subjects remained in the Study Group for approximately 4 hours, which was the same amount of time that the AI Group averaged on the computer.

Figure 3-10. CRT Console in TOSSOC

When you see	Type (Exactly as spaced)
LOG IN OR END	(Your I.D. - example H2304163) then press the black SEND Button
ENTER COMMAND	GET INTRO - then press the black SEND Button
IDENTIFY YOURSELF	(Your I.D. - example H2304163) then press the black SEND button
When you take a break	>FINISHED - then press the black SEND button
When asked what course	A for Crew Served Weapon (LAW) B for Tactics C for GED Math THEN press the black SEND button

Figure 3-11. Instructions for AI Group

Figure 3-12. AI Group Taking Course

Figure 3-13. Study Group in Portavan 3

As in all groups, they were free to take coffee and latrine breaks whenever they so desired, and broke for lunch when the PX truck arrived.

The Study Group monitor remained in the Portavan during the study period but was instructed not to offer help or assistance on the materials studied.

3. Control Group. The Control Group was sent to Portavan 2 (Figure 3-14) and given instruction in the Alpha Dot Code (Figure 3-15), an experimental method of providing battlefield data to a computer data base using a small, cigarette package size electronic device containing six dots. (Refer to Appendix F for sample instruction and code sheets.) The subjects learned the alphabet, numerals, and punctuation marks using combinations of the six dots that resembled the way they normally would be printed.

After learning the alphabet, each subject practiced writing scripted messages on paper and pencil forms (Figure 3-16). When the required number of messages had been satisfactorily completed, the subject went on-line with the Alpha Dot Equipment, which was linked by phone line to the ARI center in Washington. Rate of transmission and error scores on each subject were then obtained.

Subjects spent approximately 4 hours training time on Alpha Dot, the same amount of time as the AI and Study Groups spent on their activities.

Basically, the Control Group activities during the 4-hour period kept these subjects occupied in activities unrelated to training in Crew Served Weapons, Tactics or GED Math. The Control Group also served the practical purpose of furnishing the U.S. Army Research Institute with subject experience in the use of the Alpha Dot system. Essentially, this was a partial study within a study, and the Alpha Dot results will be reported separately by ARI under the overall study of which it is a part.

Figure 3-14. Control Group in Portavan 2

e. Posttest

At the end of the test period, subjects were administered the posttest in Portavans 2 and 3. They took the opposite version of the pretest, e.g., Version A on pretest, Version B on posttest, and vice versa. Subjects were allowed as much time as they required to take the posttest. Monitors noted the start and end times on the test cover sheet for each subject. Monitors remained in the Portavans throughout the entire test period.

f. Interview

Following scoring of the posttest, subjects in the AI Group were interviewed in depth in regard to their experience with computer-assisted instruction (CAI) (Figure 3-17). SDC and ARI personnel conducted the interviews, using the interview form as a basis. The interviewer filled out the form based upon the subject's responses. Some questions were open ended and others required a specific answer. Two versions of the Crew Served Weapons and Tactics Interview Form were used: The second updated version changed the positive end of some questions from the beginning alternative to the end alternative and revised slightly, dropped or added certain questions. A separate questionnaire was used for the AI subjects taking GED Math. These interview forms are shown in Appendix G.

Interviews were recorded on SONY and CRAIG cassette tape recorders unless the subject objected to being recorded (one subject did object).

Interviews took place in each of the three Portavans, behind the Portavans and in cars parked near the vans--wherever space and sufficient quiet were available. At the beginning, two interviews were occasionally recorded in the same van at the same time. This resulted in some overlap of voices on the two concurrent interviews being recorded; furthermore, occasional telephones ringing, helicopters passing overhead, and trucks passing by on the road would be picked up by the sound track. These, however, were not disruptive.

Figure 3-17. Interviewing AI Group Subject in Portavan 1

Section 4: ANALYSIS OF RESULTS

A. INTRODUCTION

The data were analyzed to determine the degree to which (1) significant gains in GED subject matter learning took place as a result of AI training, and (2) this learning was comparable to or better than that obtained by current study methods.

Subjects were preselected initially for this study on the basis of their 11B40 MOS Proficiency Test Scores and a GT score of 88 or above. Those 11B40 personnel in this pool of subjects who had not met high school equivalency requirements were assigned to the GED Math study. As the study developed, most of the 11B40 personnel whose records in August showed they lacked the high school equivalency requirement had by now (September) met the requirement. Consequently, for the GED Math protion of the study only, the subject pool was supplemented by additional personnel who met the lowered requirements of a GT score of 78 or above (slightly below the Dull Normal Level), with a 7th Grade education level or above, and unrestricted as to MOS or paygrade. The result was that most of the GED Math subjects had an education level of 7th, 8th, or 9th Grade and were in the E1, E2, and E3 paygrades.

GED Math subjects were given a pretest and then assigned at random to one of three treatment groups: Automated Instruction (AI), Study (S), or Control (C). After experiencing their assigned treatment condition, they were given the posttest. The dependent variable used to determine the amount of learning that took place was the gain score, i.e., the posttest score minus the pretest score on an instrument expressly designed to measure GED relevant subject matter in the area being trained. Independent Student's t tests were made to determine the statistical significance of critical experimental differences, namely those occurring between the AI Group and the Control Group and the AI Group and the Study Group.

A series of analyses was conducted in order to test for possible contaminating influences in data that might have affected the validity of the critical experimental comparisons. Another series of analyses dealt with attitudinal data gathered from interviews with AI subjects concerning the relative acceptability of computerized training by military personnel. Still another series of analyses sought to isolate pertinent learning concepts in computerized GED training that might be of value in assisting the Army to establish such training on a sound footing.

B. RESULTS OF THE GED MATH STUDY

1. Statistical Analysis

a. Comparison of AI, S and C Group Performance

(1) Critical Comparisons

The two critical comparisons of this study are between: (1) the AI and Control Groups and (2) the AI and Study Groups. The statistics upon which these comparisons are made are shown in Table 4-1.

TABLE 4-1. RESULTS OF THE GED MATH STUDY

TREATMENT GROUP	n	MEAN PRETEST SCORE (Var. 6)	MEAN POSTTEST SCORE (Var. 7)	PERCENT INCREASE PRETEST TO POSTTEST	MEAN GAIN SCORE (Var. 25)	GAIN SCORE STANDARD DEVIATION
AI	30	10.267	17.533	71%	7.266	5.285
S	15	9.5333	14.333	50%	4.800	4.648
C	14	8.429	9.000	7%	0.571	4.363

The AI Group had a mean gain score of 7.266, a 71% increase in proficiency over their pretest scores. The Control Group had a mean gain score of 0.571, a 7% increase in proficiency over their pretest scores. The difference in mean gain score between the AI and Control Groups is 6.695 (7.266 - 0.571). The t test was used to determine if this difference was statistically significant. With 42 degrees of freedom and a standard error of the difference of 1.624, this difference produces a t ratio of 4.12, which is significant at the .01 level (.01 significance = ratio of 2.70). The t ratio shows that the possibility of the mean difference of 6.695 occurring by chance is remote. Consequently, this difference can be attributed to training given the AI Group. *The significant t ratio and the 71% increase in proficiency are positive statistical and practical evidence that learning takes place by means of automated instruction.*

The Study Group had a mean gain score of 4.800, a 50% increase in proficiency over their pretest scores (as compared to 71% for the AI Group, a difference of 21% in favor of the AI Group). The difference in mean gain score between the AI and Study Groups is 2.466 (7.266 - 4.800). With 43 degrees of freedom and a standard error of the difference of 1.608, this difference produces a t ratio of 1.534 in favor of the AI Group, which is not significant at the .05 level (.05 = t of 2.02). Although there was a 42% increase in proficiency over the Study Group $\left(\frac{71\% - 50\%}{50\%} = 42\% \right)$, the statistical evidence does not show that learning by means of automated instruction is more effective than Study Group methods of training.

Although not as germane to the study, the differences between the Study Group and Control Group produced a t ratio of 2.52 which, with 27 degrees of freedom, is significant at the .05 level (.05 = t ratio of 2.06, .01 = t ratio of 2.77). *Thus the Study Group had a significant gain in learning when compared to the Control Group, although not as great as that of the AI Group.*

A point to be raised is whether some of the GED subjects were ready to take the GED Math Decimals module. The progression in Math courses is to master the basic arithmetic skills of addition, subtraction, multiplication and division prior to entering Decimals. There was no prior screening as to whether the GED subjects had these basic arithmetic skills and it is suspected that a number did not, particularly those who scored very low on the pretest. If those scoring 3 or below on the pretest were eliminated from the statistical analysis (four from the AI Group, none from the Study Group, and two from the Control Group), the results would change as follows:

	From			To		
	Degrees of Freedom	t ratio	Significance	Degrees of Freedom	t ratio	Significance
AI vs Control	42	4.12	.01	36	4.50	.01
AI vs Study	43	1.53	-	39	2.17	.05
Study vs Control	27	2.52	.05	25	2.37	.05

The t ratios for the AI Group versus the Control Group would increase and the Study versus Control Group would decrease, with the level of significance remaining the same. The AI Group versus Study Group results, however, would now show significant differences in gain score in favor of the AI Group.

(2) Equivalence of AI, S, and C Groups

A number of variables were examined to determine whether, in spite of random assignment to the three groups, one or more groups were favored (biased) in regard to background variables or pretest scores and pretest time. The means and standard deviations on these variables are shown in Table 4-2. Posttest score and time and gain score are also included to present the test data as well. The frequency distributions for these variables are provided in Attachment A.

TABLE 4-2. GED MATH STUDY GROUP MEANS AND STANDARD DEVIATIONS

VARIABLE NAME (NO.)	AI GROUP (n=30)		STUDY GROUP (n=15)		CONTROL GROUP (n=14)	
	M	SD	M	SD	M	SD
GT Score (26)	91.4	8.3	86.9	6.3	93.8	8.3
Education (4)	8.6	0.9	8.7	0.6	9.5	1.1
Age (5)	22.2	4.9	21.7	3.8	20.7	6.0
Paygrade (2)	3.6	1.1	3.1	1.2	2.6	1.7
Pretest Score (6)	10.3	5.0	9.5	3.9	8.4	4.7
Pretest Time (21)	31.6	9.1	38.3	18.0	27.0	8.9
Posttest Score (7)	17.6	8.9	14.3	6.6	9.0	6.1
Posttest Times (23)	23.9	9.9	35.1	14.0	20.1	9.5
Gain Score (25)	7.3	5.3	4.8	4.6	0.6	4.4

The results in Table 4-2 show significant differences (.05 level) in GT score (Var. 26), pretest time (Var. 21), and education (Var. 4). There are only chance differences (greater than .05) in pretest score (Var. 6), age (Var. 5) and paygrade (Var. 2). Both the Control and AI Groups had higher GT scores than the Study Group. The Study Group took longer than the Control Group on the pretest. The Control Group had a higher education level than the AI or Study Groups.

These differences are not regarded as having a serious effect on the critical comparisons made above, since the correlations of pretest score (Var. 6) with pretest time (Var. 21), education (Var. 4), age (Var. 5) and paygrade (Var. 2) are low, ranging from -.26 to .31, and are well within chance probabilities, with the differences primarily in favor of the Control Group. The correlation between pretest score (Var. 6) and GT score (Var. 26), though higher, ranging from .17 for the AI Group to .48 for the Study Group, is still within chance probabilities for the sample size involved.

(3) Intercorrelation of Variables

The intercorrelation matrix for each of the three groups for the variables listed in Table 4-2 is given in Attachment B. These matrices are computed from the individual values shown in Attachment C. The correlation coefficients, rounded to two decimal places without the decimal point, are shown in the upper half of each matrix, while the number of subjects on which each coefficient was based is shown in the lower half of each matrix.

Of particular interest in the intercorrelation matrices is the relationship of pretest (Var. 6), posttest (Var. 7), and gain score (Var. 25) to GT score (Var. 26) for each of the three GED Math groups--AI, S and C. These have been plotted in Figures 4-1, 4-2, and 4-3. Posttest and pretest scores are plotted on the y axis and GT score on the x axis. The legend explains the entries. Maximum test score is 32. For the AI Group, there is a significant correlation ($r = .44$) between GT score (Var. 26) and gain score (Var. 25) and between posttest score (Var. 7) and GT score ($r = .36$). The remaining correlations are within chance probabilities.

In comparing gain scores for the AI and S Groups (Figures 4-1 and 4-2), the AI Group was fairly consistent in showing substantial gain scores as opposed to the S Group. The AI Group had 20 (67%) with gain scores of 7 or above versus 4 (27%) in the Study Group. This is also evidenced in comparing the number of AI subjects who scored 20 or above, 17 (57%), with the number of S subjects, 4 (27%), who scored 20 or above. Since not all AI subjects finished the GED Math course in the allotted time period, the posttest and gain scores shown for the AI Group in Figure 4-1 would have been expected to increase still further as compared to those for the S Group, had they been allotted time to finish.

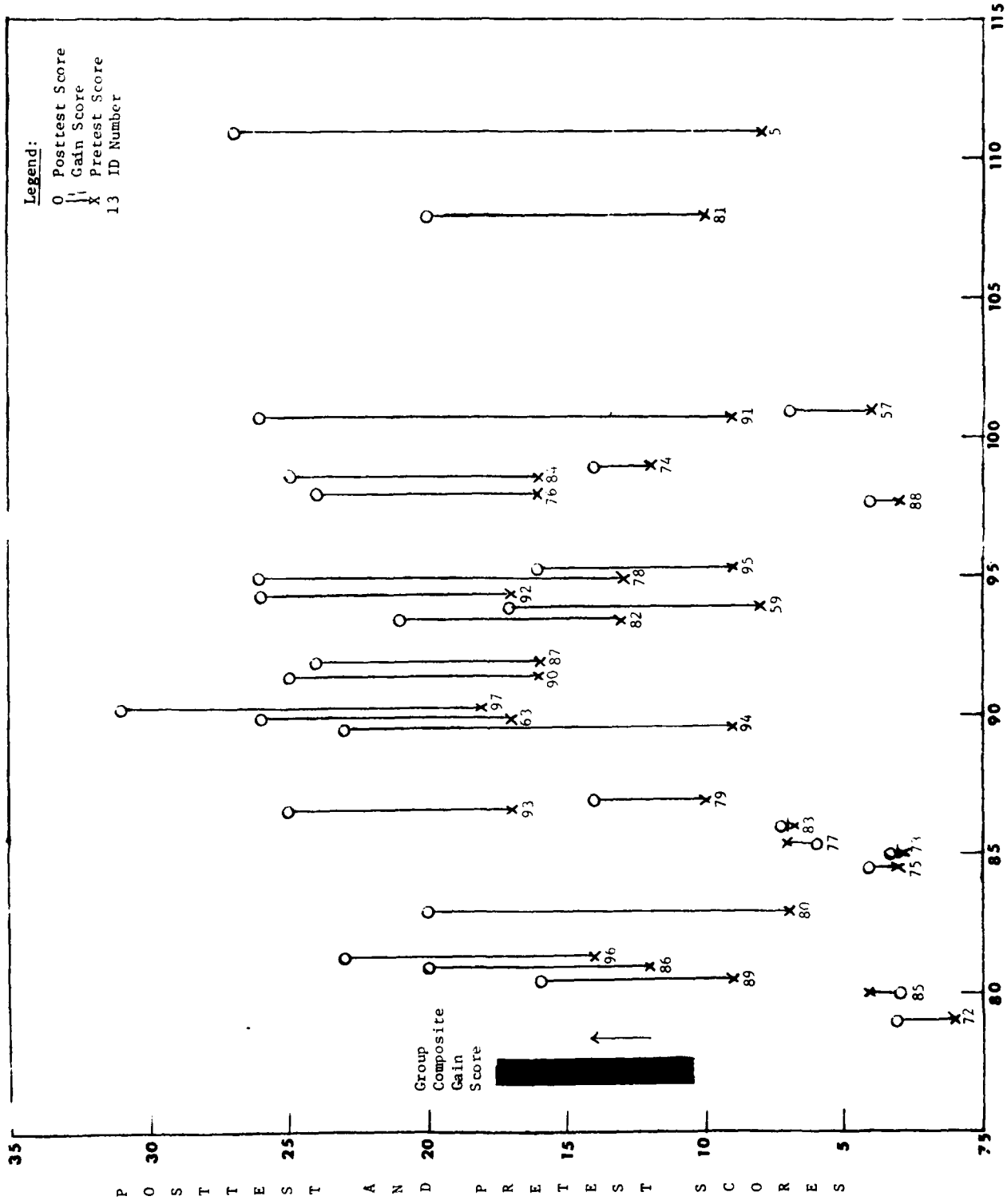


Figure 4-1. Relationship of Pretest, Posttest and Gain Scores to GT Scores for GED AI Subjects (n = 30)
(Correlation between Gain and GT is .44)

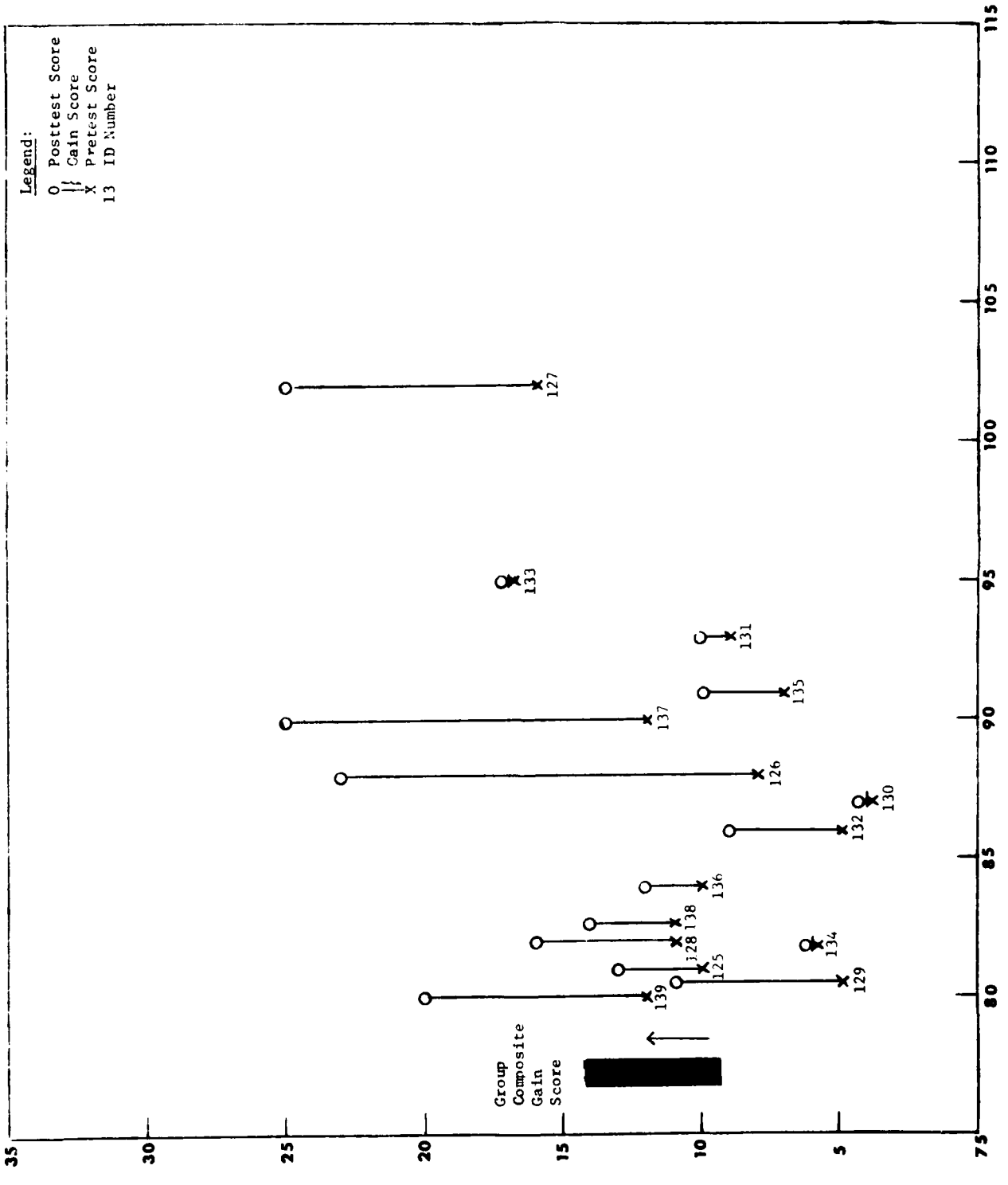


Figure 4-2. Relationship of Pretest, Posttest and Gain Scores to GT Scores for GED S Subjects (n = 15)
(Correlation between Gain and GT is .13)

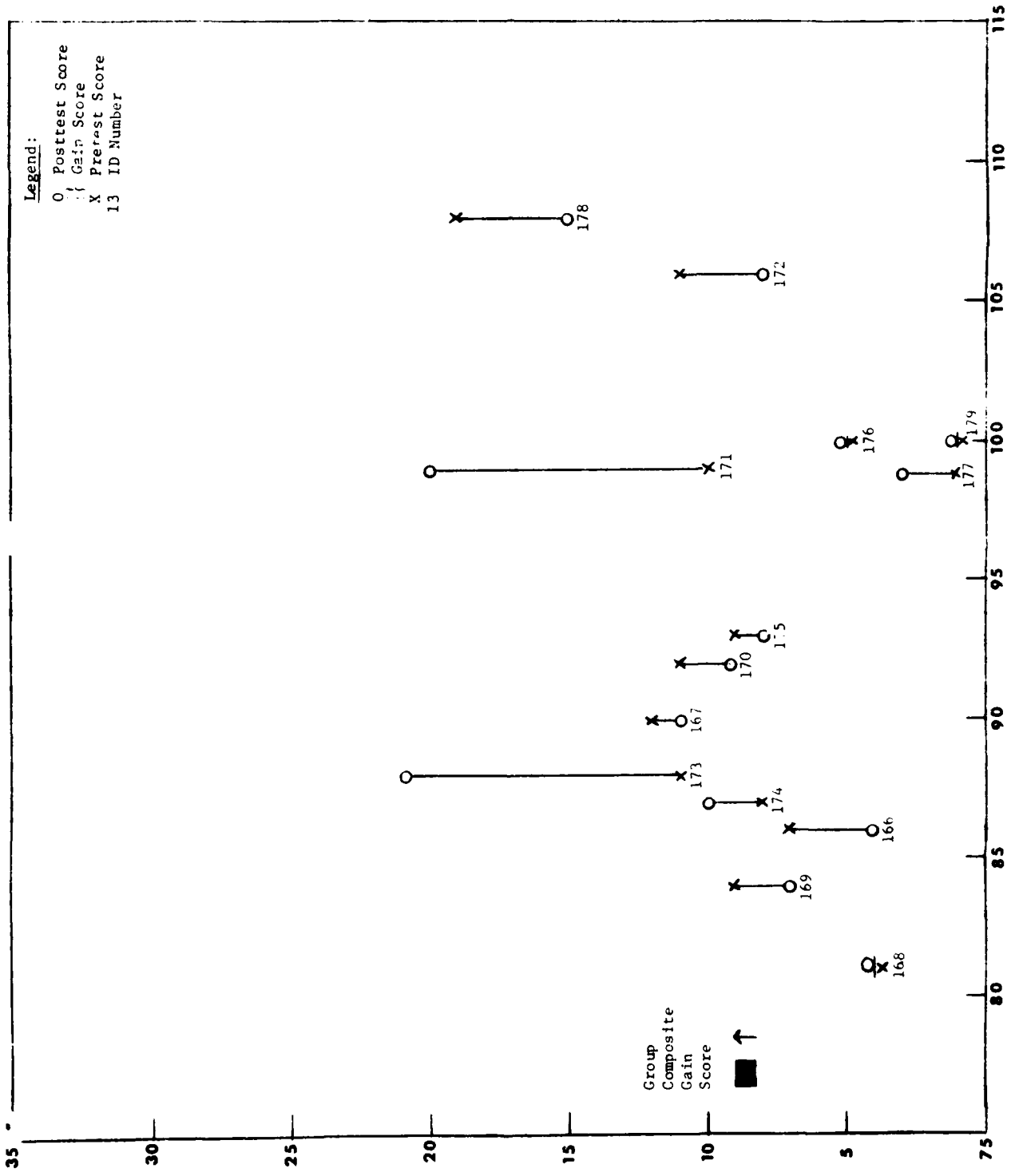


Figure 4-3. Relationship of Pretest, Posttest and Gain Scores to GT Scores for GED C Subjects (n = 14)
(Correlation between Gain and GT is .-11)

b. Analysis of AI Group Results

(1) Introduction

There were 66 variables analyzed for the 30 subjects in the GED Math AI Group. Attachment D provides the frequency distribution of scores for each variable. The means, standard deviation, range of scores for each variable, plus the intercorrelation matrix for the 66 variables are presented in Attachment E. Scores for each subject are shown in Attachment F. As previously explained, coefficients rounded to two decimal places without the decimal point are shown in the upper half of each matrix, while the number of subjects on which each coefficient is based is shown in the lower half of each matrix.

(2) The Relation of Paygrade, Education, and Age to Automated Instruction

The intercorrelation matrix in Attachment E shows that paygrade (Var. 2), education (var. 4), and age (Var. 5) have low negative correlations, from -.11 to -.15, with gain score (Var. 25). These correlations, well within chance probabilities, indicate that there is no evident relationship between these variables and learning by means of automated instruction. *Thus, automated instruction appears to be effective across age groups, across education level, and across the paygrades of the GED Math population.*

(3) The Relation of GT Score to Automated Instruction (AI)

GT score is derived by combining the verbal (VE) and arithmetic reasoning (AR) scores on the Army Classification Battery (ACB) and dividing by 2. GT is considered a measure of general aptitude or ability to learn. Combat arms personnel, many of whom are in the lower ranges of GT score, are considered to present special problems in training for the military services.

The results of this study show that the automated instruction method of training applies fairly well to both high and low GT groups. As shown in Figure 4-1, subjects in the lower GT scores have posttest scores which compare somewhat favorably to those with higher GT scores. The 15 subjects with the lowest GT

scores (90 and below) had an average posttest score of 14.93 and the 15 highest (92 and above), an average of 20.13. The correlation between GT score (Var. 26) and gain score (Var. 25) is .44. However, as shown in Figure 4-1, seven of those with GT scores of 90 and below (almost half) had posttest scores of 20 or above. There is some question also whether a number of subjects in this group had the basic arithmetic skills of addition, subtraction, multiplication and division, which are prerequisite for taking the Decimals module. The six subjects who scored 4 or less on the pretest had a mean gain score of 1. If such subjects were eliminated and the study were replicated, it is reasonable to expect that the results would have shown little or no difference in performance between those with low and high GT scores. *In any case, the results of this study clearly show that substantial numbers of low GT scorers benefit by means of automated instruction.*

(4) How the AI Group Took the Course

The course variables are Total FL Frames (Var. 31), Total Entries (Var. 35), Total Course Time (Var. 39), FL Frames per Minute (Var. 43), Entries per Minute (Var. 47), and Entries per FL Frame (Var. 51). Frequency distributions for the variables are shown in Attachment D; the means, standard deviations, and range of scores are provided in Attachment E.

There were five lessons in the GED Math Decimals course. The FL Frames (Var. 31), which is the minimum path or fast line through the course, for each lesson are as follows:

Lesson Name	FL Frame	Cumulative FL Frames
DEC1	56	56
DEC2	51	107
DEC13	5	112
DEC32	28	140
DEC4	9	149

Six of the 30 AI Group subjects completed the course in the time period allotted, 16 were in or had completed Lesson 4, 7 were in or had completed Lesson 3, and 1 was in Lesson 1. The specific number of FL Frames reached, i.e., the stopping point for each subject, is given in the frequency distribution for Var. 31, Total FL Frames, in Attachment D. The correlation between total FL Frames (Var. 31) and posttest score (Var. 7) is .58.

The total course time (Var. 39) for the 30 subjects averaged 236 minutes and ranged from 163 to 271 minutes.

The speed with which FL Frames were executed is given by the FL Frames per Minute (Var. 43 in Attachment D). The fastest execution rate, .71 per minute, is approximately 2 times the slowest, .41 per minute (ignoring the .09 entry). The fastest Entries per Minute (Var. 47) execution rate is approximately 2 times the slowest, from 1.90 per minute to .93 per minute (ignoring the .52 entry). The number of Entries per FL Frame (Var. 51) is also about 2 times, from 1.80 to 3.33 (ignoring the 5.31 entry).

(5) How Slow Learners Took the Course

To get an answer to this question, a ratio was obtained for each AI subject from the data contained in Attachment F. The Total Entries (Var. 35) for each subject was divided by the Total FL Frames (Var. 31), which was the minimum fast line (FL) path to the point reached by the subject in the course. This ratio is the number of entries made for each FL Frame.

The ratios for the fastest 14 and the slowest 15 (ignoring the 5.31 entry) on Total Course Time (Var. 39) are as follows:

Fastest 14 (245 minutes and below)		Slowest 15 (above 245 minutes)	
Entries Per FL Frame (Var. 51)	Time	Entries Per FL Frame (Var. 51)	Time
3.33	(195)	1.99	(258)
1.97	(217)	2.79	(250)
2.35	(230)	2.48	(258)
2.11	(209)	2.58	(269)
2.21	(245)	1.80	(271)
2.29	(228)	1.99	(266)
2.09	(213)	3.12	(250)
2.88	(238)	2.61	(259)
2.09	(239)	2.36	(250)
2.94	(228)	2.77	(252)
2.39	(222)	2.11	(249)
2.55	(232)	2.48	(246)
2.13	(198)	2.84	(267)
2.80	(185)	2.17	(251)
		2.26	(255)
Total 34.13		Total 36.35	
Mean 2.44		Mean 2.42	
n = 14		n = 15	

On the average, the slowest 15 subjects made .02 entry (2.44 - 2.42) more per FL Frame than the fastest 14. This amounts to one additional entry every 50 FL Frames reached. This relatively small difference would indicate that the slower learners went through the AI course in almost the same way as the fast learners and simply required more time to read and comprehend the material.

2. Analysis of GED Math Subjects' Attitude toward Automated Instruction (AI)

Following the posttest, subjects in the AI Group were interviewed to determine any problems they had had in regard to automated instruction and their reactions to CAI. A questionnaire was used by each interviewer to structure the interview and record the responses. The questionnaire, with the variable number and

scoring for each question, are shown in Appendix G. The interviews were recorded on cassette tapes. Responses to the questionnaire (Vars. 58 through 122) are contained in Attachment D (frequency distributions) and Attachment E (means, standard deviations and range of scores). The positive end of the alternatives was scored highest, e.g., very effective scored 5; effective, 4; etc.

The response of 11B40 personnel is overwhelmingly in favor of automated instruction. They were practically unanimous (ratios of 27 to 2 or better):

- In liking automated instruction (Var. 58) and in believing their test scores would be significantly improved (Var. 77)
- In stating that the computer method is more effective than Army classroom instruction (Var. 107)
- In being willing to volunteer to take AI (Var. 83)
- In thinking this method of instruction is effective (Var. 67)
- In stating that computer courses like these should be made available to Army personnel (Var. 82)
- In believing that new methods of training such as AI would make Army instruction better (Var. 94) and more interesting (Var. 95)

A cross-section of comments made by military personnel during the interviews are recorded in Appendix H. These comments elicit the following characteristics:

- Characteristics of Automated Instruction
  1. Quiet
  2. Work at own pace
  3. Provides feedback
  4. Individualized instruction
  5. No disruption as in classroom
  6. Not an adversary situation
  7. Individual teaching himself
  8. Requires positive action to progress satisfactorily
- Characteristics of Course Development
  1. Easy to understand
  2. Material has continuity and integration
  3. Builds on knowledge of subject--remedial, if required
  4. Considered accurate by the student
  5. Provides the facts without the B.S.
  6. Eliminates unnecessary material
- Characteristics of the Learner
  1. Challenge
  2. Mastery over equipment
  3. Can understand what is said
  4. Rewarding situation, sense of individual progress and achievement, able to advance in the lesson
  5. Measured achievement--right or wrong--difference between pretest and posttest

The variations in student patterns of progress through the lessons, the fact that learning did occur, and the observed attentiveness of subjects during the AI learning, all tend to corroborate the interview statements.

3. Discussion of Findings

a. Introduction

In reviewing the results of the study, two basic comparisons were made between the Automated Instruction (AI) Group and the Control (C) Group and between the AI and Study (S) Groups. Mention should be made of the Study Group conditions. The Study Group received the materials used for the USAFI course in General Mathematics, D-151 and D-152, consisting of the textbook and study guide for the course, plus additional material on solving word problems. This material not only includes the decimals subject matter area but also sections on the basic arithmetic skills of addition, subtraction, multiplication and division. If the subjects in the Study Group were deficient in these arithmetic skills, they had a ready reference source at their disposal, should they have desired to use it. This reference source was not available to the AI Group. This fact, in favor of the Study Group, should be kept in mind in interpreting the comparative results between the AI and Study Groups.

b. Learning Taking Place - Gain Score

The significant differences in gain score between the AI Group and the Control Group show that learning takes place by means of automated instruction. The significant differences in gain score between the Study and Control Groups shows that learning also takes place by means of organized self-study in a classroom situation. The statistical differences in gain score between the AI and Study Groups are not significant, and consequently do not show that automated instruction is more effective than organized self-study in a classroom situation. However, the AI Group did show a 42% increase in proficiency over the Study Group and there is some question as to whether some number of the AI Group had the basic arithmetic skills prerequisite for taking Decimals.

It should be noted that both the Control and AI Groups had higher GT scores than the Study Group, that the Study Group took longer than the Control Group on the pretest, and that the Control Group had a higher education level. The intercorrelations of these variables with pretest score are low, within chance probabilities, so that these differences do not have a material effect on the results obtained.

c. Posttest Time - A Measure of Confidence

Pretest and posttest times for the AI, S and C Groups were as follows:

	AI	S	C
Pretest (Var. 21)	31.6	38.3	27.0
Posttest (Var. 23)	23.9	35.1	20.1
Difference	7.9	3.2	6.9

All three groups took less time on the posttest. However, the AI Group took 7.9 minutes less as compared to the S Group, which took 3.2 minutes less--a difference of 4.7 minutes.

This time difference (in conjunction with higher gain scores for the AI Group) can perhaps be considered a measure of confidence in the knowledge and skills learned, i.e., knowing you are right. This phenomenon is borne out by statements made by the AI subjects during the conduct of their interviews, and can be attributed to the fact that in AI instruction, the subject was tested throughout the course and given positive feedback to that effect. This element of knowing you are right when you are right and wrong when you are wrong is apparently missing in the classroom or when self-study methods are employed.

d. Attitude Toward AI

The response to and acceptance of automated instruction by military personnel in this study is striking, as indicated by the recorded responses to questions asked during the interview. The taped interviews show not only an acceptance

of automated instruction, but an enthusiastic response to this method of training. All except one of the 30 AI subjects, for example, would voluntarily go to a computer learning center to take AI in preparation for a GED test.

e. Applicability of GED AI to Training Army Personnel

While the sample population of subjects is fairly small (n = 30), they do cover a fairly wide range of enlisted personnel. Their length of service ranges from 6 months to 20 years, in paygrades 2, 3, 4 and 5; GT scores range from 79 to 111; education ranges from 7th to 10th grade; ages ranges from 17 to 42, averaging 22 years. The sample comprises men of different races and different ethnic backgrounds, including Spanish-speaking personnel. Consequently, they can be considered a fair cross-section of enlisted personnel in the Infantry and other combat arms who have not met their high school equivalency requirements. Therefore, the results obtained in this study can be expected to be replicated with other similar groups of enlisted personnel in the combat arms.

f. Applicability of AI to Military Personnel with Lower GT Scores

The results indicate that some, not all, personnel with lower GT scores are brought up to a level of performance that compared favorably with the performance of personnel with higher GT socres. Of the six subjects with the lowest GT scores (83 or below), three had posttest scores of 20 or above, and one had a posttest score of 16.

This result is important in considering methods of training to increase the performance level of enlisted personnel in the lower GT score brackets. It also has some bearing on the general Army problem of training personnel in the lower range of GT scores. Fifty percent of the AI Group had GT scores of 90 or below. Automated instruction resulted in effective training in GED Mathematics. It is highly probable that automated instruction would also result in effective MOS training for these personnel.

g. Applicability of AI to Those with English-Language Problems

Interviews with Spanish-speaking personnel and others in this study who have problems comprehending the English language indicated that automated instruction allows them the opportunity to read and re-read the material until it is understood. They indicated that language problems make it difficult to understand instructors and to ask questions in class; texts provide no diagnosis and feedback. Automated instruction apparently overcomes these problems and provides a positive, nonthreatening learning experience for these personnel.

Section 5: CONCLUSIONS AND RECOMMENDATIONS

A. INTRODUCTION

The following conclusions and recommendations have been derived by SDC project personnel as a result of the GED Mathematics portion of this study on the application of tactical computers for training.

B. CONCLUSIONS

- A sophisticated CAI system, PLANIT, has been successfully installed on the DEVTOS tactical computer.
- GED Mathematics courseware has been developed and successfully executed on the tactical computer.
- Automated Instruction (AI) is effective in providing GED Mathematics training for enlisted personnel. These enlisted personnel state AI is an effective and easy way to learn, and the increase in proficiency (gain scores) proves that they do indeed learn.
- Automated Instruction is well accepted by enlisted personnel. They like it, accept it, and would like to see other GED courses presented in this manner.
- Enlisted personnel prefer automated instruction over study methods of training by a ratio of 23 to 3; they prefer AI training over classroom training by a ratio of 18 to 1.
- AI training has the effect of reducing or overcoming the verbal handicaps usually associated with lower GT scores. Furthermore, automated instruction is effective for personnel in both the higher and lower ranges of GT scores.
- Automated Instruction has the effect that the same number of entries relative to particular topics are made by both slow learners and fast learners. The difference is that slow learners need more time to read and understand the material, rather than extensive remedial material.

- Automated Instruction holds the attention of the students, requires that they think about what they are doing, and patiently provides the time in which to think and learn.
- Automated Instruction provides a positive learning experience in a nonthreatening environment.

C. RECOMMENDATIONS

- As a result of this study, the U.S. Army now has Automated Instruction (AI) courses in the GED Mathematics areas covering Decimals, Percent, and Interpreting Data. There is a continued need for this type of training by Army personnel who have not met the high school equivalency requirement.

  It is recommended that the GED AI courses be installed on a trail basis, using remote consoles, at an Education Center, such as that at Fort Hood, Texas. Such implementation will serve primarily to increase the educational level of Army personnel and, secondarily, to to enhance the training image of the U.S. Army by providing a dynamic example of how subjects can be taught in this medium.

- The AI GED Mathematics course covers Decimals, Percent and Interpreting Data which is approximately 15% of the subject matter area for the GED test in General Mathematical Ability. The remaining areas cover whole numbers, fractions, algebra, ratio and proportion, and geometry.

  Because of the success of the AI method of instruction, it is recommended that additional courses be developed to cover Whole Numbers, Fractions, Algebra, Ratio and Proportion and--to the extent practicable--Geometry.

- Army use of AI is expected to expand. This expansion will eventually include personnel in the lower GT ranges. It is important to the Army to be able to differentiate between those who can and cannot benefit from such training and to identify the factors that account for the difference between the two. The results of this study show that many of those subjects in the lower GT ranges do as well--or almost as well--as those in the higher GT ranges; some, however, do not. This difference is not accounted for by education, age, paygrade or GT score.

  It is recommended that a study be undertaken to determine those factors that discriminate between Army personnel in the lower GT ranges who do and do not benefit from AI training.

- As a result of this study, it has been determined that automated instruction is effective in teaching GED mathematics to lower ranking enlisted personnel in the lower GT score brackets. It is quite probable that AI would be effective in providing MOS training for these personnel as well. AI courses developed as part of this study in both the Crew Served Weapons and Tactics areas have been field tested on combat infantry NCOs with excellent results. However, they have not been tried out on enlisted personnel in the lower paygrades, a number of whom fall into the lower GT score range.

  It is recommended that an evaluation be made to determine the extent to which Automated Instruction is an effective means of providing MOS training to E-1, E-2 and E-3 enlisted personnel in the lower range of GT scores.

- New Army tactical data systems are in the process of development and installation. One of these is TOS^2. As part of this study, SDC analyzed the DEVTOS system to identify the requirements which must be met by an AI program in order to operate within the system.

  It is recommended that similar studies be conducted on new Army tactical data systems including TOS^2 to determine the problems which may exist in implementing AI on these systems.

- The TOS^2 tactical data system is being installed at Fort Hood, Texas. This system will not be operational for some time. This capability can probably be utilized for AI both prior to and after the system is operational. It is anticipated that AI can be used to provide GED Mathematics training on AI courses already developed, either at the TSDG facility at West Fort Hood or by remote terminals in the Fort Hood Education Center on the main post. A second use would be to develop AI course materials to train personnel in the operation of the tactical system, using the tactical consoles. An added benefit of such a training program would be the early identification of user problems in operating the system.

  It is recommended that: (1) an AI system be implemented on the TOS^2 tactical system, (2) the system be used to provide GED Mathematics training for the 2nd Armored and 1st Cavalry Division personnel, and (3) AI course materials be developed to train TOS^2 tactical system operators and identify problem areas in regard to system use.

- Tactical computers are being designed specifically to carry out the operational mission. This is the primary purpose. However it is probable that minor modifications in design would permit the Army to use tactical computers to carry out the training mission, manage the training process, test personnel proficiency on the computer, plus other uses.

  It is recommended that the tactical data system design concepts be analyzed to: (1) identify the problem areas in extending the use of tactical computers, (2) identify the modifications that would be required, and (3) identify alternatives and the costs and benefits of implementing such modifications.

APPENDIX A

TRAINING ANALYSIS RESULTS FOR GED AI MATH

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1. Explanatory Material

AUTOMATED INSTRUCTION TRAINING ANALYSIS
FOR THE GED MATHEMATICS MODULE

The U.S. Army is conducting an experiment to determine the feasibility of using tactical (TAC) computer systems for purposes of automated instruction (AI) at the unit level. The materials contained in this document reflect results of the training analysis performed in conjunction with the development of the GED mathematics materials for the TAC/AI experiment.

Four GED mathematics subject areas have been selected for conversion into AI format. These are:

- Decimals
- Percent
- Interpreting data
- Using algebra

The training analysis data has been organized into five sections for each of these units. The five sections deal with: content development, task hierarchies, training analysis information, criterion and enabling objectives, and criterion and enabling test items. A brief description of each section follows:

1. Content Development. On the left side of each page the logical order of subject matter development for each unit is shown. Directly across the page, the primary performance tasks and subtasks are arranged hierarchically in accordance with the decimal numeration scheme shown. That is, for Task 1.0 the enabling subtasks include those labeled 1.1, 1.1.1, 1.2, 1.2.1, and so forth. The preponderance of tasks require

that the student solve problems. Since the GED high school equivalency test is concerned primarily with applied mathematics, the emphasis throughout our tasks, objectives, and items is applied performance.

2. Task Hierarchy. Block diagrams graphically depict relationships among tasks identified in the Content Development outlines. The decimal numeration remains consistent throughout our materials, and therefore permits cross referencing within this document.

3. Training Analysis Information Sheet (TAIS)

This sheet specifies in detail the subject matter areas identified in the Content Development and the Task Hierarchy sections of this document. The major task identification number is carried at the top, with numeration of tasks at second and third levels appearing in the Task Element and Subelement columns. For each major task the performance conditions are stated, and performance standards required to evaluate mastery of criterion test items are stated. Supplemental training materials additional to the CAI/AI module are also listed, as required. To date, only one unit, Interpreting Data, requires supplementary materials--handouts showing bar, line, and combined line and bar graphs will be needed for reference by the students.

4. Criterion and Enabling Objectives. These correspond directly both to task elements and subelements on the TAIS, and to the criterion and enabling test items. Objectives are stated behaviorally in

all cases, in so far as this is possible for abstract subject matter, such as mathematics.

5. Test Items. Because performance and application of learned skills has been emphasized, items require either that students solve problems and state numeric answers, or that they state numeric steps or expressions obtained during the problem solving process. This is particularly appropriate for the AI mode of instruction which permits a variety of equivalent student numeric responses and algebraic expressions to be matched automatically to the course author's target number or expression. Constructed verbal responses can also be similarly matched in a computerized training mode. Multiple choice and matching items have also been included, especially where students are being taught to discriminate among members of a set. Test items are cross-referenced to criterion and enabling objectives, and to the task statements. Dual numerals associated with an objective or item, indicate that it it is supportive of learning of more than one task element or subelement.

In summary, this document details specifications for the development of four GED subject matter areas. These specifications have been developed as a result of the TAC/AI training analysis.

2. Decimals

MODULE GED
UNIT Decimals

CONTENT DEVELOPMENT

Subject Matter Outline	General Task/Objective
I. Place Values	1.0 Reads and writes decimal numbers < 1.0 and >1.0.
A. Review whole number place values; units, tens, hundreds, thousands...	1.1 Places the decimal point in common word phrases so that they read logically.
B. Concept of decimal place position and place value; tenths, hundredths, thousandths...	1.2 Identifies word statements which represent decimal numbers.
	1.3 Constructs decimal numbers to denote word statements.
C. Equivalence of missing place values to zero. Decimal numbers with and without leading or trailing zeros.	1.4 Converts decimals to their fractional equivalents.
D. Decimal numbers as fractions with denominators that are powers of 10.	
II. Rounding-Off Decimals	2.0 Rounds whole numbers and decimal numbers to precision specified.
A. Next rightmost digit as determining digit.	2.1 Rounds where determining digit is < 5 or > 5.
B. Rule when decision digit is midpoint.	2.2 Rounds where determining digit is 5.
C. Examples and practice.	
III. Basic Decimal Operations	3.0 Solves numeric decimal problems for sums, remainders, products, and quotients.
A. Analogy to whole number arithmetic operations.	3.1 Obtains sums and remainders for
B. Operations where decimal numbers contain an unequal number of digits.	3.2 problems where the decimal numbers contain equals and unequal numbers of digits, and which require carrying or borrowing.
C. Determining number of decimal places in a product or quotient.	3.3 Obtains products of decimal numbers, with carrying required.

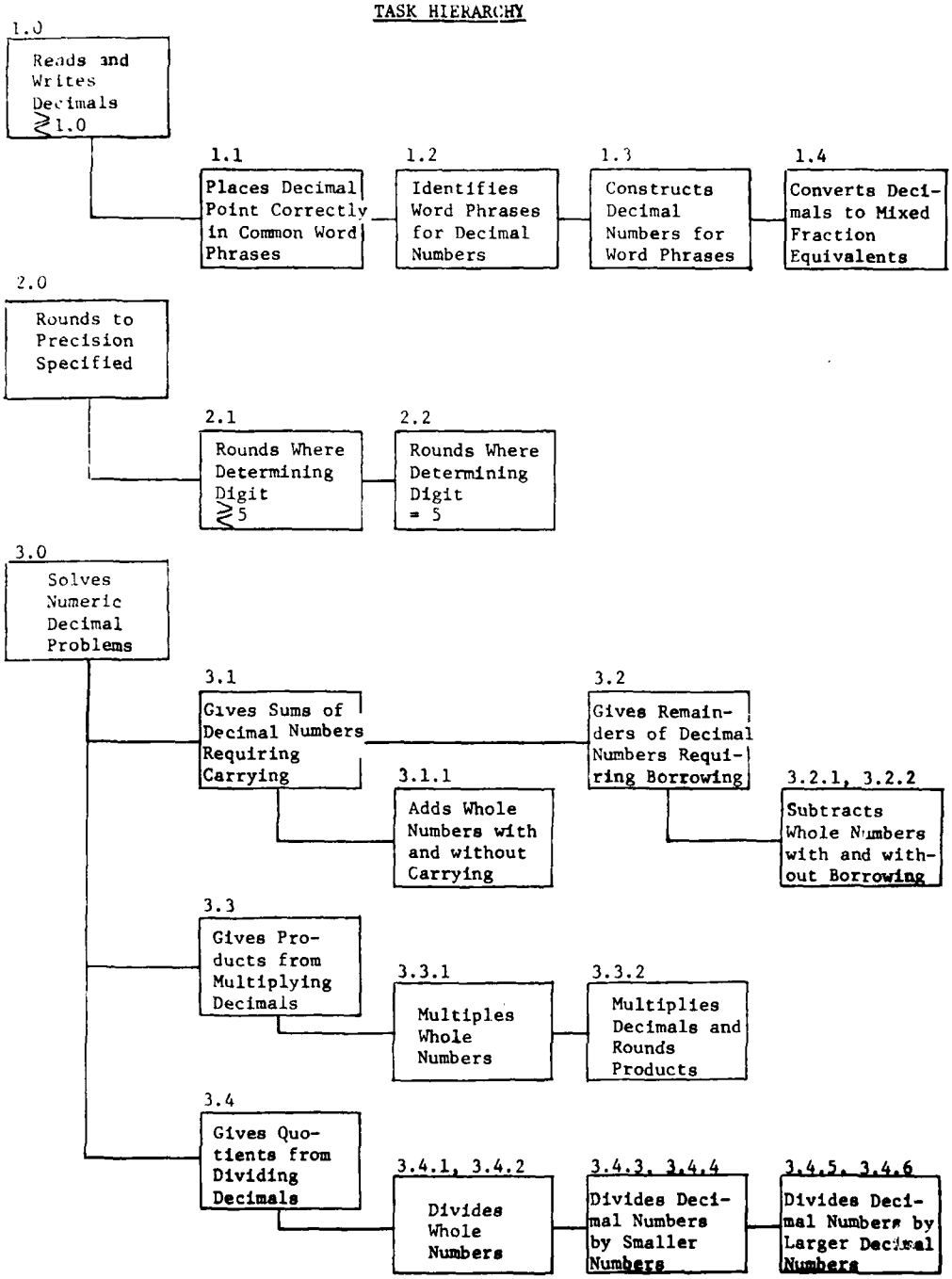
MODULE GED
UNIT Decimals

CONTENT DEVELOPMENT (Cont'd)

Subject Matter Outline	General Task/Objectives
D. Where divisor is larger than dividend.	3.4 Obtains quotients from decimal dividends divided by whole number and decimal divisors.
E. Rounding off uneven quotients.	
IV. Solving Decimal Word Problems	
A. Examples: GED and life analogy.	4.0 Solves word problems requiring individual or successive steps of adding, subtracting, multiplying, and/or dividing decimal numerals.
B. Five steps in procedure for solving word problems.	4.1 States correct order of steps in problem solving.
C. Reading problem carefully to find important words.	4.2 Identifies and performs problem solving steps in problems of increasing difficulty.
D. Picking out and stating the facts; converting word phrases to numbers in finding facts.	4.3 Identifies important problem facts.
E. Finding the question to be answered and the answer units; recognizing the precision required for an answer.	4.4 Identifies question to be answered and answer units.
F. Deciding upon the type of operation(s) required; word clues to determining if things are coming together, separating, coming together in equal sized sets, or separating into equal sized sets.	4.5 Decides type and order of arithmetic operations required
G. Problems where more than one type and sequence of operations is possible.	4.6 Obtains and labels the answer.
H. Working the problem; computing, checking, and labeling an answer.	

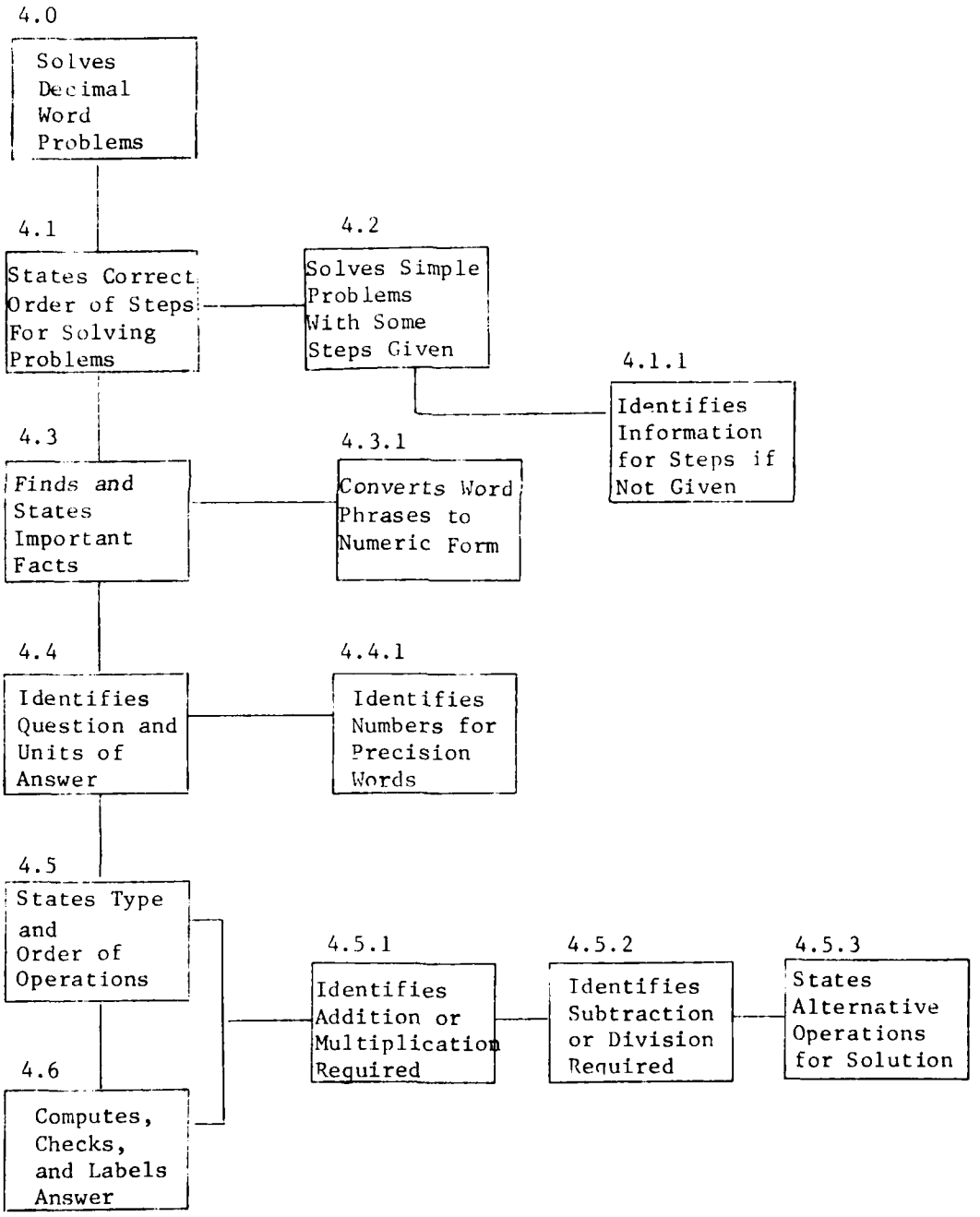
MODULE GED
UNIT Decimals

TASK HIERARCHY



MODULE GED
UNIT Decimals

TASK HIERARCHY (Contd.)



TAIS No. 3001

MODULE GED

UNIT Decimals

TOPIC Place Values

TRAINING ANALYSIS INFORMATION SHEET

1. TASK IDENTIFICATION: 1.0

2. TASK: Reads and writes decimal numbers < 1.0 and > 1.0.

3. CONDITIONS: Given common word phrases, decimal numbers, and mixed numbers

4. STANDARD: No errors, or at least two consecutive correct in series of three presentations.

5. TASK ANALYSIS:

TASK ELEMENTS	SUB ELEMENTS	SUPPLEMENTAL TRAINING MATERIAL	REFERENCES
1.1 Places decimal point in common word phrases so that they read logically	1.1.1 Reads common word phrases	None	Brown, Snader, &Simon. General Mathematics, Book 1. (USAFI D151/D152), 1968, Chapter 4, pgs 171-192, 207-211.
1.2 Identifies word statements which represent decimal numbers	1.1.2 Recognizes, finds, and types decimal point symbol		
1.3 Constructs decimal numbers to represent word phrases	1.2.1 Identifies place positions of digits in a decimal number		Brown, Snader, & Simon. General Mathematics, Book 1, Manual, Tests, Answers. (USAFI D151/D152) Part I, Chapter 3 & 4. Part II, Tests, pgs 50, 61-64. Part III, Answers, pgs A18-A21.
1.4 Writes mixed number and fraction equivalents of decimal numbers	1.2.2 Equates place postions with place values of decimal numbers		
	1.2.3 Identifies the digits for given place values in decimal numbers		
	1.2.4 Recognizes the place values where numbers are/are not present in a decimal number		

(Continued on following page)

TAIS No. 3001 (contd.)

MODULE GED

UNIT Decimals

TOPIC Place Values

TRAINING ANALYSIS INFORMATION SHEET

1. TASK IDENTIFICATION: 1.0 (contd.)

2. TASK:

3. CONDITIONS:

4. STANDARD:

5. TASK ANALYSIS:

TASK ELEMENTS	SUB ELEMENTS	SUPPLEMENTAL TRAINING MATERIAL	REFERENCES
	1.3.1 Converts mixed 1.4.1 numbers to decimal numbers 1.3.2 Gives decimal number 1.4.2 equivalents to word statements expressing decimal fractions	None	Hockett, S. GED Mathematics Home Study Guide. Lesson 6, Barron's, 1972. Niederkorn, General Mathematics 1 Study Guide. USAF1, 1968, Lessons 6, 11, & key.

TAIS No. 3001

MODULE GED

UNIT Decimals

TOPIC Place Values

CRITERION AND ENABLING OBJECTIVES

TASK IDENTIFICATION: 1.0

TASK ELEMENTS: 1.1 - 1.4
1.1.1 - 1.4.2

CRITERION OBJECTIVE(S)	ENABLING OBJECTIVE(S)
1.1 Given common word phrases of weight, dollars, and measure, PLACE the decimal point so that the phrase reads correctly.	Used as Organizer and for subelement skills 1.1.1 & 1.1.2.
1.2 MATCH quantifiable word phrases with the decimal numbers they represent.	1.2.1 Given a decimal number, IDENTIFY which number is in which of four place positions.
	1.2.2 Given a list of place values and a list of place positions, correctly MATCH the place positions with place values.
	1.2.3 Given decimal numbers STATE how many tenths, hundredths, thousandths, and ten-thousandths are shown.
	1.2.4 Given a decimal number, IDENTIFY in which of two places numbers are/are not present.
1.3 CONSTRUCT decimal numbers given quantifiable word statements	1.3.1 Given mixed numbers with denominators 1.4.1 as powers of 10, STATE the decimal number equivalents.
1.4 Given decimal numbers, WRITE fraction and mixed number equivalents.	1.3.2 Given word statements expressing 1.4.2 decimal fractions, STATE the equivalent decimal numbers.

TAIS No. 3001

MODULE GED

UNIT Decimals

TOPIC Place Values

TEST ITEMS

TASK IDENTIFICATION: 1.0

TASK ELEMENTS: 1.1 - 1.4
1.1.1 - 1.4.2

CRITERION ITEM(S)	ENABLING ITEM(S)
1.1 Used as organizer and for subelement skills 1.1.1 and 1.1.2, as well as one criterion item.	1.1.1 See if you can decide where to put the 1.1.2 decimal point in the numbers so that each of the next sentences makes sense. First...
1.2 Which of these numbers says two-tenths? (choose a letter... A B C) A .002 B 0.2 (B) C 0.200	Big Pete weighs 2403 pounds. (type the number with a decimal point (240.3) John would have to pay $289999 for a brand new small car. (type $289999 with a decimal point) ($2899.99) The thickness of one sheet of newspaper is 0025 inches. (.0025)
Which number says twenty-seven and three tenths? A 27.3 (A) B 27.30 C 27.003	1.2.1 In the decimal number 35.0621, the number 6 is in what decimal place? (second) In 35.0621 the 2 is in what decimal place? (third) In 35.0621 the 0 is in what decimal place? (first) In 35.0621 the 1 is in what decimal place? (fourth)
Select one hundred fifty-one and thirty-nine hundredths. A 159.39 B 151.039 C 151.39 (C)	
1.3 Write the next three statements as decimal numbers. Forty-seven hundredths = ? (.47, 0.47) Five and seven tenths = ? (5.7) Four hundred ninety-five and five hundredths = ? (495.05)	1.2.2 Here are some decimal place values A Hundreds B Ten-thousandths C Tenths D Thousandths Give the letter for the 'place value' that goes with the decimal 'place position' I ask for. Here's a place position... First decimal place = ? (Select a letter) (C) Second decimal place = ? (A) Third decimal place = ? (D) Fourth decimal place = ? (B)
1.4 Give the fraction or mixed number for the decimal number. .333 = ? (333/1000, 333/1,000) 151.51 = ? (151 51/100, 15151/100 15,151/100) 5.25 = ? (5 25/100, 5 1/4, 525/100, 21/4)	

TAIS No. 3001 (contd.)

MODULE GED

UNIT Decimals

TOPIC Place Values

TEST ITEMS

TASK IDENTIFICATION: 1.0 (contd.)

TASK ELEMENTS: 1.1 - 1.4
1.1.1 - 1.4.2

CRITERION ITEM(S)	ENABLING ITEM(S)
	1.2.3 In 6.0589, what is the number in the tenths place? (0)
	What is the number in the hundredths place in 6.0589? (5)
	What is the number in the thousandths place in 6.0589? (8)
	What number is in the ten-thousandths place in 6.0589? (9)
	What number is in the tenths place in the decimal number .6425? (6, six)
	In .6425 what number is in the hundredths place? (4, four)
	What number is in the thousandths place of .6425? (2, two)
	What number is in the ten-thousandths place of .6425? (5, five)
	1.2.4 In 0.7 is there a number in the tenth's place (yes/no)? (yes)
	In 0.7 is there a number in the hundredths place? (no)
	1.3.1 Write decimal numbers for each of the 1.4.1 following mixed numbers.
	1 30/100 = ? (1.30)
	253 9/10 = ? (253.9)
	16 1/1000 = ? (16.001)
	1.3.2 Write the decimal numbers for the 1.4.2 next four word statements.
	Sixty-two hundredths (.62, 0.62)
	Fourteen thousandths (.014, 0.014)
	Ten hundredths (.10, 0.10)
	One-hundred thousandths (.100, 0.100)

TAIS No. 3002

MODULE GED

UNIT Decimals

TOPIC Rounding Off

TRAINING ANALYSIS INFORMATION SHEET

1. TASK IDENTIFICATION: 2.0

2. TASK: Rounds whole and decimal numbers to the precisions specified.

3. CONDITIONS: Given a series of problems requiring rounding off whole numbers, mixed decimal numbers, and decimal fractions.

4. STANDARD: Rounds correctly in at least five of nine problems.

5. TASK ANALYSIS:

TASK ELEMENTS	SUB ELEMENTS	SUPPLEMENTAL TRAINING MATERIAL	REFERENCES
2.1 Rounds correctly where determining digit is <5 or >5. 2.2 Rounds correctly where determining digit is 5.	2.1.1 Chooses the most important of two decimal digits by proximity to decimal point. (2.2.1) 2.1.2 Rounds a decimal number to the specified number of places. (2.2.2) 2.1.3 Rounds a decimal number to the specified place value. 2.1.4 States whether determining digits are larger than, smaller than, or equal to 5. 2.1.5 Selects the correct rule for a rounding action. (2.2.3) 2.1.6 States the correct rounding action for given conditions of the determining digit. (2.2.4, 2.1.7) 2.1.8 Recognizes that upward rounding may result in a trailing zero, which should remain part of the answer given.	None	Same as TAIS No. 3001

TAIS No. 3002

MODULE GED

UNIT Decimals

TOPIC Rounding Off

CRITERION AND ENABLING OBJECTIVES

TASK IDENTIFICATION: 2.0

TASK ELEMENTS: 2.1 - 2.2
2.1.1 - 2.2.4

CRITERION OBJECTIVE(S)	ENABLING OBJECTIVE(S)
ROUNDS OFF mixed decimal numbers and decimal fractions to the precisions specified.	2.1.1 Given a decimal number, IDENTIFIES 2.2.1 the most important of two decimal digits.
2.1 ROUNDS a set of whole, mixed, and fractional numbers where determining digit is $\lesseqgtr 5$.	2.1.2 Given a decimal number and the number 2.2.2 of places to which it is to be limited, ROUNDS the number correctly.
2.2 ROUNDS correctly where determining digit is 5.	2.1.3 Given a decimal number and the place value to which it is to be limited, ROUNDS the number correctly.
	2.1.4 Given the results of rounding off a decimal number to stated place values, STATES whether the determining digit was larger than, smaller than, or equal to 5.
	2.1.5 Given a list of alternatives for when 2.2.3 to round upward by 1, SELECTS the alternative indicating that the determining number is "5 or larger than 5".
	2.1.6 Given that the determining digit is 2.2.4 5 or >5, STATES that the last place of the answer will be increased by 1.
	2.1.7 Given that the determining digit is <5, STATES that the number in the last place of the answer will not change.
	2.1.8 Given the results of two examples, RECOGNIZES that if rounding results in a trailing zero, the answer should include the zero.

TEST ITEMS

TASK IDENTIFICATION: 2.0

TASK ELEMENTS: 2.1 - 2.2
2.1.1 - 2.2.4

CRITERION ITEM(S)	ENABLING ITEM(S)
2.1 Round 153.8 to the nearest whole number (154) Round 226.0980 to the nearest hundredth (226.10) Now, round these decimals as specified. 0.2789 to the nearest hundredth (0.28, .28) 0.1120 to the nearest tenth (0.1, .1) 2.2 Round 2.508 to the nearest unit (whole number) (3) Now, round the next four mixed and fractional decimals as specified. 372.459 to the nearest tenth (372.5) Round 965.9750 to the nearest hundredth (965.98) Round 0.0516 to the nearest tenth (0.1, .1) Round 0.8358 to the nearest hundredth (0.84, .84)	2.1.1 In... 8.38542 ...which is more 2.2.1 important, 5 or 4? (5, five) 2.1.2 .08021 limited to 3 places becomes? 2.2.2 (.080, 0.080) 2.1.3 Round 6.831 to tenths. (6.8) 2.1.4 "Roundoff" gave you 3 numbers for 3.746 ... 3.746 rounded to the 'ones' place = 4 3.746 rounded to 'tenths' = 3.7 3.746 rounded to 'hundredths' = 3.75 Compare 3.746 with these results. When you said to round to 'ones', was the next place to the right in 3.746 larger than 5, smaller than 5, or equal to 5? (larger) However, when you said to round to 'tenths' "Roundoff" gave you 3.7 for 3.746. Was the number in the hundredths place larger than, smaller than, or equal to 5? (smaller) 2.1.5 The number in the place to which you 2.2.3 are rounding will always be increased by one when the next number to the right is . (select a letter) A 5 or larger than 5 (A) B only when larger than 5 C only when 5 D only when smaller than 5 2.1.6 In rounding off decimal numbers, only 2.2.4 consider the next number to the right of the place to which you are limiting your answer. If the next number is 5 or larger than 5, you'll increase the number in the last place of your answer by...? (1, 1.0, one) 2.1.7 ...but if the next number is less than 5, will the number in the place to which you are rounding change? (no)

TAIS No. 3002 (contd.)

MODULE GED

UNIT Decimals

TOPIC Rounding Off

TEST ITEMS

TASK IDENTIFICATION: 2.0 (contd.)

TASK ELEMENTS: 2.1 - 2.2
2.1.1 - 2.2.4

CRITERION ITEM(S)	ENABLING ITEM(S)
	2.1.8 When you rounded .699 to tenths, you got .7. What did you get rounding .699 to hundredths? (.70, 0.70) If I round off as specified by a math problem and my number ends in a zero, then my answer should include the zero (true or false?) (true)

TAIS No. 3003

MODULE GED

UNIT Decimals

TOPIC Basic Operations

TRAINING ANALYSIS INFORMATION SHEET

1. TASK IDENTIFICATION: 3.0

2. TASK: Solves numeric decimal problems for sums, remainders, products, and quotients.

3. CONDITIONS: Given successive sets of problems requiring addition, subtraction, multiplication, and division of whole and decimal numbers (NOTE: student has choice of vertical or horizontal problem formats for addition, subtraction, and multiplication drill, and for addition and multiplication criterion test items)

4. STANDARD: Error-free addition and subtraction. No more than one wrong answer for each whole number multiplication or division problem. At least one correct for each type of decimal multiplication and division problem. Maximum of five tries to reach three correct for each type of drill exercise.

TASK ELEMENTS	SUB ELEMENTS	SUPPLEMENTAL TRAINING MATERIAL	REFERENCES
3.1 States sums of adding decimal numbers.	3.1.1 Adds whole numbers with equal and unequal numbers of digits, without and with carrying. 3.1.2 Adds decimal numbers with equal numbers of digits with carrying. 3.1.3 Adds decimal numbers with unequal numbers of digits with carrying.	None	Same as TAIS No. 3001
3.2 States remainders from successively subtracting decimal numbers.	3.2.1 Subtracts whole numbers with equal and unequal numbers of digits without borrowing. 3.2.2 Subtracts whole numbers with unequal numbers of digits with borrowing.		

TRAINING ANALYSIS INFORMATION SHEET

1. TASK IDENTIFICATION: 3.0 (contd.)

2. TASK:

3. CONDITIONS:

4. STANDARD:

5. TASK ANALYSIS:

TASK ELEMENTS	SUB ELEMENTS	SUPPLEMENTAL TRAINING MATERIAL	REFERENCES
	3.2.3 Subtracts decimal numbers with unequal numbers of digits with borrowing.		
3.3 States products of decimal numbers multiplied by whole and decimal numbers.	3.3.1 Multiplies sets of whole numbers with varying number of digits.		
	3.3.2 Multiplies sets of two decimal numbers with varying numbers of digits and rounds products.		
3.4 States quotients from decimal dividends divided by whole and decimal divisors.	3.4.1 Divides whole number into larger whole number dividend for even quotient.		
	3.4.2 Divides whole number into smaller whole number dividend and gives decimal quotient to precision specified.		

TAIS No. 3003 (contd.)

MODULE GED

UNIT Decimals

TOPIC Basic Operations

TRAINING ANALYSIS INFORMATION SHEET

1. TASK IDENTIFICATION: 3.0 (contd.)

2. TASK:

3. CONDITIONS:

4. STANDARD:

5. TASK ANALYSIS:

TASK ELEMENTS	SUB ELEMENTS	SUPPLEMENTAL TRAINING MATERIAL	REFERENCES
	3.4.3 Divides whole number into larger decimal number dividend for finite decimal quotient. 3.4.4 Divides decimal number into larger decimal number for finite quotient. 3.4.5 Divides decimal number into smaller decimal number for finite decimal quotient. 3.4.6 Divides decimal number into smaller decimal number and rounds uneven quotient to two places.		

TAIS No. 3003

MODULE GED

UNIT Decimals

TOPIC Basic Operations

CRITERION AND ENABLING OBJECTIVES

TASK IDENTIFICATION: 3.0

TASK ELEMENTS: 3.1 - 3.4
3.1.1 - 3.4.6

CRITERION OBJECTIVE(S)	ENABLING OBJECTIVE(S)
3.1 Given four decimal numbers with uneven numbers of digits in terms, ADDS by carrying and STATES sums.	3.1.1 ADDS two whole numbers with the same number of digits, ADDS three whole numbers with uneven numbers of digits, and STATES sums.
3.2 Given two decimal numbers with uneven numbers of digits in terms, SUBTRACTS by borrowing and STATES remainder.	3.1.2 ADDS two decimal numbers with the same number of digits by carrying and STATES sum.
3.3 Given decimal numbers to be multiplied by whole and decimal numbers of uneven numbers of digits, MULTIPLIES the terms and STATES products rounded off as specified.	3.1.3 ADDS two decimal numbers with uneven numbers of digits by carrying and STATES sum.
3.4 Given problems with decimal number divisors smaller and larger than decimal number dividends, DIVIDES and STATES decimal number quotients.	3.2.1 SUBTRACTS two whole numbers with the same number of digits and SUBTRACTS two whole numbers with uneven numbers of digits without carrying and STATES remainders.
	3.2.2 SUBTRACTS two whole numbers with unequal numbers of digits by borrowing and SUBTRACTS the results from a third whole number by borrowing and STATES the remainders.
	3.2.3 SUBTRACTS two decimal numbers with uneven numbers of digits and SUBTRACTS the positive remainder from a third decimal number by borrowing and STATES the remainder.
	3.3.1 MULTIPLIES two whole numbers having the same number of digits and MULTIPLIES the product with another whole number of less digits and STATES the product.
	3.3.2 MULTIPLIES three sets of two decimal numbers with differing numbers of digits and STATES products rounded as specified.

TAIS No. 3003 (contd.)

MODULE GED

UNIT Decimals

TOPIC Basic Operations

CRITERION AND ENABLING OBJECTIVES

TASK IDENTIFICATION: 3.0 (contd.)

TASK ELEMENTS: 3.1 - 3.4
3.1.1 - 3.4.6

CRITERION OBJECTIVE(S)	ENABLING OBJECTIVE(S)
	3.4.1 DIVIDES a whole number divisor evenly into a larger whole number dividend and STATES quotient. 3.4.2 DIVIDES a whole number divisor into smaller whole number dividend and STATES quotient to three decimal places. 3.4.3 DIVIDES a whole number divisor into larger decimal number dividend and STATES the finite decimal quotient. 3.4.4 DIVIDES a decimal number dividend by a smaller decimal number divisor and STATES the finite quotient. 3.4.5 DIVIDES a decimal number dividend by a larger decimal number divisor and STATES the finite decimal quotient. 3.4.6 DIVIDES a decimal number dividend by a larger decimal number divisor and STATES quotient rounded to two places.

TAIS No. 3003

MODULE GED
UNIT Decimals
TOPIC Basic Operations

TEST ITEMS

TASK IDENTIFICATION: 3.0

TASK ELEMENTS: 3.1 - 3.4
3.1.1 - 3.4.6

CRITERION ITEM(S)	ENABLING ITEM(S)
3.1 Add 307.9 42.1 9.87 712.03 (1071.90) OR 307.9 + 42.1 + 9.87 + 712.03 = ? (1071.90)	3.1.1 Add the following 50 + 35 = (85) 900 + 1 + 935 = (1836, 1,836)
	3.1.2 Add these 364.785 + 199.009 = (563.794)
3.2 Subtract 4.789 from 11.91 (7.121) Subtract the result from 8.09 (.969, 0.969)	3.1.3 Add the following .0985 + 921.985 = (922.0835)
3.3 Multiply 81 .004 to nearest tenth (.3, 0.3) OR 81 * .004 = ? (nearest tenth) (.3, 0.3)	3.2.1 Subtract the following 868 - 233 = (635) 567 - 50 = (517)
	3.2.2 Subtract 98 from 1033. (935) Subtract the remainder you just got from 1810. (875)
Multiply .987 3.4 to nearest hundredth (3.36) OR .987 * 3.4 = ? (nearest hundredth) (3.36)	3.2.3 Subtract 0.069 from 110.02 (109.951) Subtract the remainder you just got from 900. (790.049)
	3.3.1 Multiply 110 * 971 * 2 (213620, 213,620)
Multiply 1.003 5.56 to nearest thousandth (5.577) OR 1.003 * 5.56 = ? (nearest thousandth) (5.577)	3.3.2 Multiply the following and give results rounded as stated 92.29 * 1.03 = ? (to the tenths place) (95.1) 21.9 * .0175 = ? (to hundredths) (.38, 0.38) .084 * 9.915 = ? (to three places) (.833, 0.833)
3.4 Divide 2.4472 by .56 (4.37) 0.1043 by 0.4 (round to hundredths) (.26, 0.26)	3.4.1 Divide these 10310 by 5 = ? (2062) 1575 divided by 15 = ? (105)

TAIS No. 3003 (contd.)

MODULE GED
UNIT Decimals
TOPIC Basic Operations

TEST ITEMS

TASK IDENTIFICATION: 3.0 (contd.)

TASK ELEMENTS: 3.1 - 3.4
3.1.1 - 3.4.6

CRITERION ITEM(S)	ENABLING ITEM(S)
	3.4.2 Divide and give results to 3 places. Divide 2 by 500 (.004, 0.004) 10 divided by 33 (.303, 0.303) 3.4.3 Divide the following and give results to 4 places. 10.0985 by 5 (2.0197) Divide 140.0252 by 28 (5.0009) 3.4.4 Divide 1.809 by .3 (6.03) Divide 34.5 by .023 (1500, 1500.0) 3.4.5 Divide the following 12.116 by 23.3 (.52, 0.52) 0.224 divided by 0.4 (.56, 0.56) 3.4.6 Divide the next two and round to the nearest hundredth. .781 divided by 3.7 (.21, 0.21) 50.18 divided by 80.3 (.62, 0.62)

TAIS No. 3004

MODULE GED

UNIT Decimals

TOPIC Solving Word Problems

TRAINING ANALYSIS INFORMATION SHEET

1. TASK IDENTIFICATION: 4.0

2. TASK: Solves word problems by determining and performing individual or successive steps of decimal number addition, subtraction, multiplication, division, and rounding of answers.

3. CONDITIONS: Given word problems with decimal numbers or quantifiable word phrases.

4. STANDARD: At least two correct answers to the criterion problems.

5. TASK ANALYSIS:

TASK ELEMENTS	SUB ELEMENTS	SUPPLEMENTAL TRAINING MATERIAL	REFERENCES
4.0 Solves word problems and states answers to precision specified.	4.1 Sequences steps into correct order for solving word problems. 4.1.1 Solves simple word 4.2 problems and identifies information for each step where not given. 4.3 Finds and states important given facts. 4.3.1 Converts word phrases of quantity to decimal numbers. 4.4 Identifies question to be answered and units of answer. 4.4.1 Identifies numbers for words specifying precision. 4.5 States required arithmetic operation(s) and correct sequence of operations. 4.5.1 Identifies where addition or multiplication is required. 4.5.2 Identifies where subtraction or division is required.	None	U.S. Dept. of Labor. AGEP High School Self Study Program. Solving Decimal Word Problems. PM 431-26, 1969. Hockett, S. GED Mathematics Home Study Gu Lessons 8 and 9 Barron's, 1972. JCMP Revision Project. How to Teach Students to Solve Math Story Problems (DRAFT) SDC, 1972.

TAIS No. 3004 (contd.)

MODULE GED

UNIT Decimals

TRAINING ANALYSIS INFORMATION SHEET

TOPIC Solving Word Problems

1. TASK IDENTIFICATION: 4.0 (contd.)

2. TASK:

3. CONDITIONS:

4. STANDARD:

5. TASK ANALYSIS:

TASK ELEMENTS	SUB ELEMENTS	SUPPLEMENTAL TRAINING MATERIAL	REFERENCES
	4.5.3 Identifies a set of steps to solve a problem where alternate sets of steps can be used. 4.6 Computes, checks, and labels answer.		

TAIS No. 3004

MODULE GED

UNIT Decimals

TOPIC Solving Word Problems

CRITERION AND ENABLING OBJECTIVES

TASK IDENTIFICATION: 4.0

TASK ELEMENTS: 4.1 - 4.6
4.1.1 - 4.5.3

CRITERION OBJECTIVE(S)	ENABLING OBJECTIVE(S)
4.0 Given three word problems, each requiring a different series of arithmetic operations with decimal numbers, SOLVES the problems and STATES the answers obtained to the precision specified.	4.1 Given a scrambled list of the five steps for solving word problems, ORDERS the steps into the correct sequence for problem solving. 4.2 4.1.1 4.5.1 Given two word problems, one requiring a subtraction and the other a multiplication of two decimal numbers, student: (4.3) reads the problem and IDENTIFIES important facts; (4.4) STATES the question to be answered: (4.5) STATES the type of arithmetic operation to be performed; (4.6) solves the problem and STATES the remainder or the product with named units of measure. 4.2 4.1.1 4.5.2 Given a word problem requiring a division of decimal numbers, student: (4.3) STATES the important facts; (4.4) STATES the question to be answered; (4.5) STATES the operation to be performed; (4.6) solves the problem and STATES the quotient in minutes. 4.2 4.1.1 4.5.3 Given a word problem where the solution is either by a division and a multiplication, by two divisions, or by addition, student: (4.5) STATES correct sequence of one set of operations; (4.6) solves problem and STATES answer in minutes.

TAIS No. 3004 (contd.)

MODULE GED

UNIT Decimals

TOPIC Solving Word Problems

CRITERION AND ENABLING OBJECTIVES

TASK IDENTIFICATION: 4.0 (contd.)

TASK ELEMENTS: 4.1 - 4.6
4.1.1 - 4.5.3

CRITERION OBJECTIVE(S)	ENABLING OBJECTIVE(S)
	4.3.1 Given word phrases specifying quantity, STATES the equivalent decimal numbers. 4.4.1 Given word phrases specifying precision, SELECTS which of three answers would reflect the level of precision required.

TAIS No. 3004

MODULE GED

UNIT Decimals

TOPIC Solving Word Problems

TEST ITEMS

TASK IDENTIFICATION: 4.0

TASK ELEMENTS: 4.1 - 4.6
4.1.1 - 4.5.3

CRITERION ITEM(S)	ENABLING ITEM(S)
4.0 Think carefully and take your time on these last three problems. I want you to get at least two right. Jim earns $24.53 per day. Each day he spend $.80 on carfare, $4.50 on food and drink, $.10 on a newspaper, and $.45 on cigarettes, and at night he rents a hotel room for $8. At the end of a day and a night, how much money does Jim have left? ($10.68, 10.68, 10 68) A storage room measures 15.6 feet by 10.2 feet. Another storage room measures 20.9 feet by 14.4 feet. Find the total storage space for the two rooms combined to the nearest tenth of a square foot. (460.1 square feet, 460.1, 460.08) Truck No. 1 is able to travel thirteen and eight tenths miles on a gallon of gasoline, and its tank can hold eighteen and four tenths gallons. Truck No. 2 is able to travel fourteen and three tenths miles on a gallon of gasoline, and its tank can hold sixteen and nine tenths gallons. Which truck is able to travel farther on a full tank of gasoline? (1, one) How much farther can truck 1 travel? (12.25 miles)	4.1 Here are the 5 steps for solving word problems. A Decide which operations are to be performed B Pick out the important facts C Read the problem carefully D Compute, check, and label the answer E Pick out the question to be answered Put these in the order in which they should be performed (type the letters on a single line) (C B E A D , CBEAD) 4.2 4.1.1 4.5.1 A carpenter needs a wooden brace to fit between two studs that are 16.35 inches apart. He has a piece of lumber 20.9 inches long from which to make the brace. After making the brace, how much lumber will he have left over? There are two important facts in this problem What is one fact? (key words & numbers) The other fact is...? (brace 16.35 lumber 20.9, 16.35 20.9, 20.9 16.35) What is the question being asked? What does the problem want to know? (lumber left, inches, left over, leftover) What arithmetic operation must you use to solve this problem? (20.90-16.35, 20.9-16.35, subtraction, subtract, minus, -, take away) Now compute your answer. (4.55 inches, 20.90-16.35)

TAIS No. 3004 (contd.)

MODULE GED
UNIT Decimals
TOPIC Solving Word Problems

TEST ITEMS

TASK IDENTIFICATION: 4.0

TASK ELEMENTS: 4.1 - 4.6
4.1.1 - 4.5.3

CRITERION ITEM(S)	ENABLING ITEM(S)
	(Contd.) 4.2 A painter needs 15 gallons of paint to 4.1.1 paint a house. Each gallon costs $5.25. 4.5.1 What will be the total cost of the paint? This time you tell me the first step. What's the first thing you must do? (read problem, read) Now you've read the problem. What is the next step to take? (find facts, facts) There are two important facts. One of these facts is...? (15 gallons $5.25, The other fact is...?15 5.25, 5.25 15) Now you have the facts. What is the next step? (question, asked, asks) What is the question asked by this problem? (cost of paint, total, cost, dollars, $) You have read the problem, stated facts, and stated the question to be answered. What is the next thing to do? (operation, operations, arithmetic, math) State the arithmetic operation to solve this problem. (* , multiply, multiplication) Now write the math statement. ? * ? (5.25*15, 15*5.25) You have written the math statement to solve the problem. What is your last step? (compute, work, solve, check, label) Now, give the answer. (78.75, $78.75, 78 75)

TAIS No. 3004(contd.)

MODULE GED

UNIT Decimals

TOPIC Solving Word Problems

TEST ITEMS

TASK IDENTIFICATION: 4.0

TASK ELEMENTS: 4.1 - 4.6
4.1.1 - 4.5.3

CRITERION ITEM(S)	ENABLING ITEM(S)
	4.2 A water tank with a total capacity of 4.1.1 68.75 gallons must be emptied for 4.5.2 cleaning. Water flows out of the tap at the rate of 5.5 gallons per minute. How long will it take to empty a full tank? State problem facts. (68.75 5.5, 5.5 The other fact is ...? 68.75, holds 68.75, 5.5 gallons minute) What is the question? What must you answer? (minutes empty, time empty, how long) What arithmetic operation must you do? (division, divide, divided, /) Write the math statement. ? / ? (68.75/5/5, 687.5/55) Give the answer. (12.5 minutes, 12.5, 12 1/2) 4.2 Read this problem carefully. Pick out 4.1.1 the facts and exactly what the question 4.5.3 asks you to find. A typist is able to type 100 words in 1.6 minutes. How many minutes will it take her to type a letter that is 250 words long? There are several ways to solve this problem. Type 'GO' when you think you know how (go) Computing the answer will take a least two arithmetic steps.

TAIS No. 3004 (contd.)

MODULE GED

UNIT Decimals

TOPIC Solving Word Problems

TEST ITEMS

TASK IDENTIFICATION: 4.0

TASK ELEMENTS: 4.1 - 4.6
4.1.1 - 4.5.3

CRITERION ITEM(S)	ENABLING ITEM(S)
	One way to solve this problem is ? (+ - * /) a) (/ *, divide multiply, division multiplication) A division followed by a multiplication does it. First you would divide... ?/? (250/100, 250.0/100) That will give how much larger one letter is than the other. Answer = ? (2.5, 2 1/2) The next step is... ? * ? (1.6*2.5, 2.5*1.6) Now give the answer. Answer = ? (4, 4.0, four) b) (/ /, two divisions, 2 divisions, divide twice) Two divisions is great! First you would divide ? / ? (100/1.6,100.0/1.6, 1000/16) Divide now and give her rate per minute. (62.5, 62 1/2) The next division step would be... ? / ? (2500/625, 250/62.5, 250.0/62.5) Fine. That will give total time for 250 words. Now do it. Answer = ? (4, 4.0, four) c) (+ , add, addition) You can do it using addition. Try it and give me your answer. (4, 4.0, four, 3.2+.8, 3.2+0.8)

TAIS No. 3004 (contd.)

MODULE GED

UNIT Decimals

TOPIC Solving Word Problems

TEST ITEMS

TASK IDENTIFICATION: 4.0

TASK ELEMENTS: 4.1-4.6
4.1.1-4.5.3

CRITERION ITEM(S)	ENABLING ITEM(S)
	4.3.1 Give the decimal number for the following statements from word problems. Fifty-two and three tenths cent per foot (<u>$.523</u>, <u>.523</u>, <u>0.523</u>) Five and sixty-five hundredths feet of pipe (<u>5.65 feet</u>, <u>5.65</u>) Thirteen and twenty-nine hundredths miles (<u>13.29 miles</u>, <u>13.29</u>) 4.4.1 Pick which one of three choices would be the correct answer for the following statements in word problems. To the nearest minute (14, 14.817, 14.82) (<u>14</u>, <u>14.0</u>) To the nearest tenth of a square foot (295.8395, 295.80, 295.8) (<u>295.8</u>) To the nearest hundredth of a mile (244.078, 244.0, 244.08) (<u>244.08</u>)

3. Percent

MODULE GED

UNIT Percent Problems

CONTENT DEVELOPMENT

Subject Matter Outline

I. Review goals of percent lessons

II. Equivalency of fractions, decimals, and percents.

A. Different ways to express the same value; e.g., twenty-nine one-hundredths= 0.29=29/100=29÷100=29%

B. Percent as a basis of comparison using base of 100.

C. Methods of converting to decimal and to percent; rules, examples, and practice:

1. Decimal-to-percent

Implicit - move decimal point two places to right, adjust zeros, replace with % sign;

Explicit - multiply decimal by 100. e.g., 1.7x100=170/100=170%; 0.125x100=12.5/100=12.5%

2. Percent-to-decimal

Implicit - move decimal point two places to left, adjust zeros, omit % symbol, e.g., 4%=.04, 4 1/2%=.045

Explicit - divide decimal by 100, e.g., 4 1/2%=4+ 1/2=4+0.5=4.5/100=.045; e.g., 12%=12/100=.12, 100%=100/100=1.0

General Task/Objective

1.0 Converts commonly used mixed numbers and fractions to decimal and percent equivalents.

1.1 Differentiates equivalent from non-equivalent fractions, decimals, and percents.

1.2 Converts decimal numbers to percents < or > 100%.

1.3 Converts whole and fractional percents to equivalent decimal numbers.

1.4 Converts mixed numbers and fractions with demoninators that are or are not factors of 100 to percent equivalents.

MODULE GED

UNIT Percent Problems

CONTENT DEVELOPMENT (Contd.)

Subject Matter Outline	General Task/Objective
3. Fraction-to-decimal-to-percent Either as an equivalent fraction with base of 100 stated as decimal, or by division with remainder as fraction, e.g., 1/2=50/100=.5=50% 26/100=.56=56% e.g., 3/4=75/100=.75=75% 3/2=150/100=1.50=150% e.g., 7/26=0.269x100=26.9% 2/3=0.666x100=66.666%=66 2/3%=66.67%	
II. Basic Operations: Simple Word Problems	
A. Word problem learning goals	2.0 Solves simple word problems for part value and for percent.
B. Finding percent of a number; i.e., What is Z% of X, given X and the percent. Step-through sample word problem, state rule as steps, practice on numeric problems, review this form of percent problem, practice on word problems.	2.1 Solves a word problem for part value, from total value and % of total. 2.1.1 Solves numerically stated problems of 2.1 type.
C. Finding percent one number is of another; i.e., What percent is Y of X, given X and Y. Sample word problem to illustrate rule "is" divided by "of" ... is/of. Give steps of rule and practice on numeric problems. Review this form of problem and give word problem practice.	2.2 Solves a word problem for percent one number is of another. 2.2.1 Solves numerically stated problems of 2.2 type.

MODULE GED

UNIT Percent Problems

CONTENT DEVELOPMENT (Contd.)

Subject Matter Outline	General Task/Objective
III. Solving Different Types of Percent Problems	
A. Review 5 steps for solving word problems	3.0 Solves word problems for part values, totals, multiple part values and remainder, percents of parts, percent profit, and pre-discount price.
B. Components of Percent word problems: total, parts, percents	3.1 Identifies important parts and facts given in problems.
C. Finding and stating problem facts	3.2 Identifies missing components to be solved for in word problems.
D. Tutorial instruction through steps in solving word problems of the following types:	3.2.1 Identifies key words denoting what the problem asks and the quantity asked for.
• Finding part value from percent of total and value of total	3.3 States or selects a math expression for solving word problems.
• Finding part value from percent of total for another part and value of total	3.4 Performs arithmetic operations and states numeric answers for word problems.
• Finding total value from a part value and percent increase (or decrease) with respect to that part	3.4.1 Finds a part value from total value and percent of total for the missing part.
• Finding a part value from total value and percent of total for each of the other parts	3.4.2 Finds a part value from total value and percent of total for the second part.
• Finding percent profit (or loss) given buying and selling prices	3.4.3 Finds a new total from a part value and percent increase with respect to current total.
• Finding percent of a part, from a total and the value of the other part	3.4.4 Finds individual part values and value of missing part from a total and percent of total for named parts.

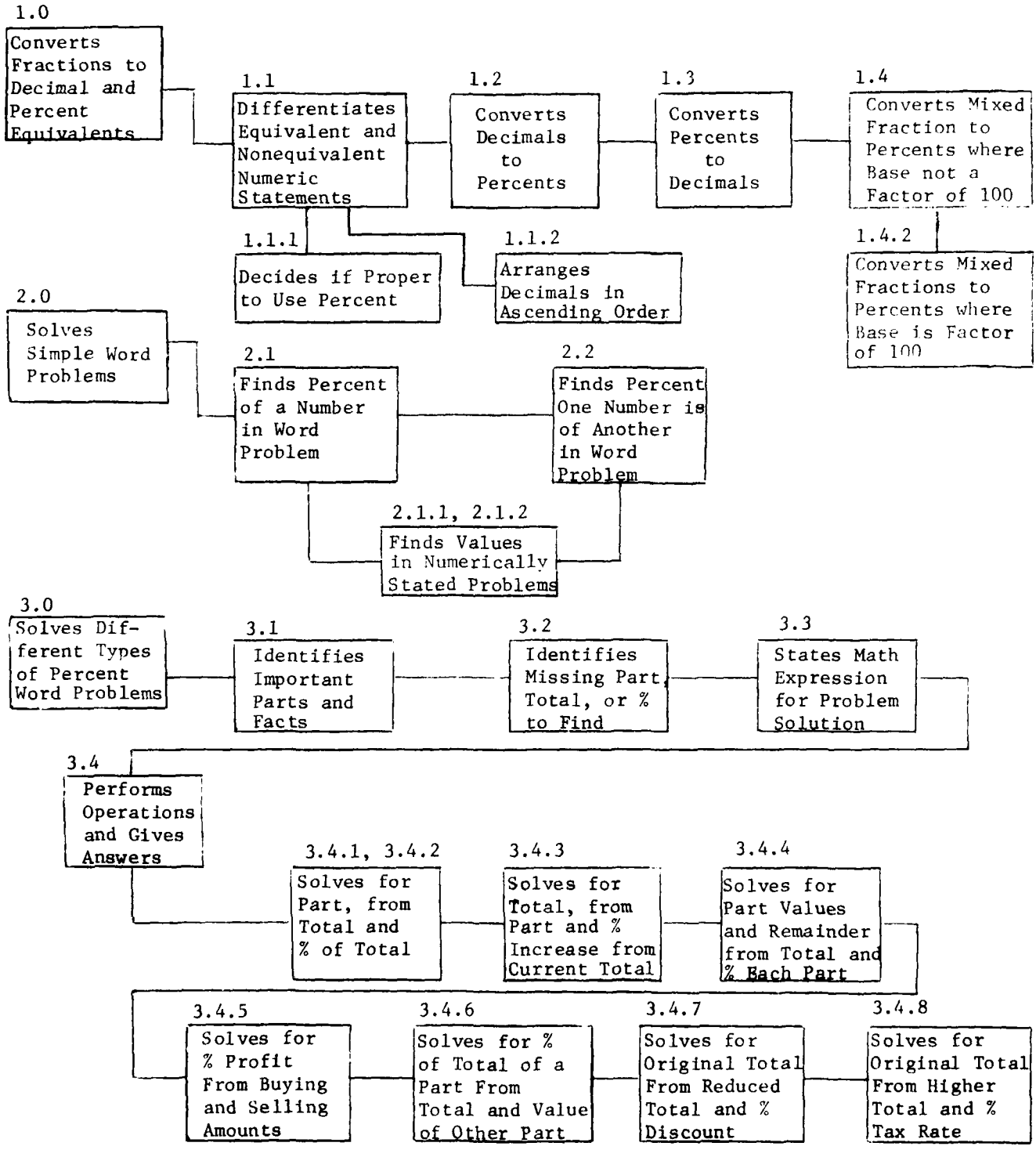
MODULE GED

UNIT Percent Problems

CONTENT DEVELOPMENT (Contd.)

Subject Matter Outline	General Task/Objective
• Finding total price from a reduced price and percent discount	3.4.5 Finds amount and percent profit from bought and sold prices
• Finding pretax price from a taxed price and percent taxation	3.4.6 Finds percent of total for a part from value of the other part and value of total.
E. Selecting and writing math expressions in solving problems of the types above.	3.4.7 Finds original total from a reduced total and percent discount.
	3.4.8 Finds pre-tax total from a taxed total and percent tax rate.

TASK HIERARCHY



TAIS No. 3005

MODULE GED

UNIT Percent Problems

TOPIC Numeric Equivalents

TRAINING ANALYSIS INFORMATION SHEET

1. TASK IDENTIFICATION: 1.0

2. TASK: Converts commonly used fractions and mixed numbers to numerically equivalent decimal and percent values.

3. CONDITIONS: Given fractions and mixed numbers.

4. STANDARD: No more than two errors in seven criterion conversions.
No more than one error per set of five enabling test problems.

5. TASK ANALYSIS:

TASK ELEMENTS	SUB ELEMENTS	SUPPLEMENTAL TRAINING MATERIAL	REFERENCES
1.0 States percent and decimal equivalents of fractions and mixed numbers by: (a) converting fractions and mixed numbers to decimal numbers (b) converting decimal numbers to percents	1.1 Differentiates numerically equivalent from non-equivalent word phrases, fractions, decimals, and percents. 1.1.1 Decides whether it is proper or not proper to use percent to express values or comparisons. 1.1.2 Arranges decimal numbers in ascending order of value. 1.2 States percent equivalents of decimal mixed numbers and decimal fractions. 1.3 States decimal number equivalents of percent values.	None	Hockett. GED Mathematics Home Study Guide. Barron's Educational Series, 1972, Lesson 7. Instructional Objectives Exchange. Math Numbers and their Operations: Rational Numbers, pages 27-52 Brown, Snader, and Simon-General Mathematics, Book 1, USAFI, 1968, pages 213-226

TRAINING ANALYSIS INFORMATION SHEET

1. TASK IDENTIFICATION: 1.0 (contd.)

2. TASK:

3. CONDITIONS:

4. STANDARD:

5. TASK ANALYSIS:

TASK ELEMENTS	SUB ELEMENTS	SUPPLEMENTAL TRAINING MATERIAL	REFERENCES
	1.4 States percent equivalents of fractions with denominators that are not factors of 100.		
	1.4.1 States percent equivalents of mixed numbers and fractions with denominators that are factors of 100.		

TAIS No. 3005

MODULE GED
UNIT Percent Problems
TOPIC Numeric Equivalents

CRITERION AND ENABLING OBJECTIVES

TASK IDENTIFICATION: 1.0

TASK ELEMENTS: 1.1 - 1.4
1.1.1 - 1.4.2

CRITERION OBJECTIVE(S)	ENABLING OBJECTIVE(S)
1.0 Given a partially complete table of percent and decimal equivalents to commonly used fractions and mixed numbers, student STATES the missing decimal and percent equivalents.	1.1 Given six numeric word-phrases, fractions, decimals, and percents, student MATCHES these with equivalent fraction and decimal representations. 1.1.1 Given a word statement of value or a word statement of comparison, student CHOOSES whether it is proper or not proper to use percent to express it. 1.1.2 Given scrambled lists of decimal numbers student will ORDER the numbers left-to-right in ascending numerical magnitude. 1.2 Given decimal mixed numbers and fractions, student STATES the percent equivalents of these numbers. 1.3 Given whole and fractional percent values, student STATES the equivalent decimal numbers. 1.4 Given fractions with denominators that are not factors of 100, student STATES these as equivalent percent values, rounded to hundredths. 1.4.1 Given a mixed number and a fraction with denominators that are factors of 100, student STATES these as equivalent percent values.

TAIS No. 3005

MODULE GED
UNIT Percent Problems
TOPIC Numeric Equivalents

TEST ITEMS

TASK IDENTIFICATION: 1.0

TASK ELEMENTS: 1.1 - 1.4
1.1.1 - 1.4.2

CRITERION ITEM(S)	ENABLING ITEM(S)
1.0 To end this lesson, I am going to ask you to change mixed numbers and fractions to decimals and percents. Here are five commonly used mixed fractions. 1 1/2 1 1/4 7/8 5/6 4/5 decimal .833 percent 125 83.3 Some of the decimals and percents for the fractions are shown. There are seven missing decimal or percent equivalents to the fractions for you to complete. Do you see this? (Yes) I'll give you the fraction and tell you if it's decimal or percent I want, then you convert the fraction to decimal or percent. Here's the first one. 1 1/2 = ? decimal (1.5) 1 1/2 = ? percent (150) 1 1/4 = ? decimal (1.25) 7/8 = ? decimal (.875) 7/8 = ? percent (87.5) 4/5 = ? decimal (.8, 0.8) 4/5 = ? percent (80)	1.1 Look at these 6 values A- twenty-nine hundredths D- 200/100 B- 62.5% E- 22/100 C- .63 F- 250% When I give you a number, choose a value it matches from these 6 choices (select letter) 2.0 = ? (choose a letter) (D, 200/100) .22 = ? (E, 22/100) 2.50 = ? (F, 250%, 250) 29/100 = ? (A, .29, 0.29, twenty-nine hundredths) 5/8 = ? (B, 62.5%, 62 1/2, 62.5) 1.1.1 Would you use percent to express... the distance from base to town? ("Yes" or "No") (No, N) Would you use percent to express... the distance from base to town compared to the distance from base to home? (Yes, Y) Would you use percent to express... the number of minutes left until your duty shift is over? (No, N) Would you use percent to express... the part of your workday left until your duty shift is over? (Yes, Y) 1.1.2 Arrange this set of decimals according to increasing value from left-to-right (Continued on following page)

TAIS No. 3005 (Cont.)

MODULE GED
UNIT Percent Problems
TOPIC Numeric Equivalents

TEST ITEMS

TASK IDENTIFICATION: 1,0

TASK ELEMENTS: 1.1 - 1.4
1.1.1 - 1.4.2

CRITERION ITEM(S)	ENABLING ITEM(S)
	1,1.2 (Cont.) A B C D .98 .097 .666 1.001 Type the letters in the right order...lowest value first (B C A D, BCAD) One more... A B C D 6.94 .01001 .1001 6.195 Arrange these, smallest-to-largest (B C D A, BCDA) 1.2 Give me the percents for the following decimal numbers: .02 = ? % (2) 2.05 = ? % (205) 0.0009 = ? % (0.09, .09) .375 = ? % (37.5, 37 1/2) .045 = ? % (4.5, 4 1/2) 1.3 Give me the decimal numbers for the following percents: 99.9% = ? (.999, 0.999) 800.1% = ? (8.001) 3% = ? (.03, 0.03) 83.3% = ? (.833, 0.833) 0.5% = ? (.005, 0.005)

TAIS No. 3005 (Cont.)

MODULE GED
UNIT Percent
Problems
TOPIC Numeric
Equivalents

TEST ITEMS

TASK IDENTIFICATION: 1.0 (contd.)

TASK ELEMENTS: 1.1 - 1.4
1.1.1 - 1.4.2

CRITERION ITEM(S)	ENABLING ITEM(S)
	1.4 Now, work out and tell me the percent values for the next fractions (rounded to hundredths) 1/7 = ? % (14.29) 2/3 = ? % (to hundredths) (66.67, 66 2/3) 3/11 = ? % (to hundredths) (27.27) 1.4.1 What are the percents for these fractions? 7/20 = ? % (35) 1 2/5 = ? % (140)

TRAINING ANALYSIS INFORMATION SHEET

1. TASK IDENTIFICATION: 2.0

2. TASK: Solves simple word problems by basic operations of finding a percent of a number, and finding the percent one number is of another.

3. CONDITIONS: Given word problems and numerically stated problems.

4. STANDARD: No errors on criterion word problems.
No more than one error per set of four numeric problems.

5. TASK ANALYSIS:

TASK ELEMENTS	SUB ELEMENTS	SUPPLEMENTAL TRAINING MATERIAL	REFERENCES
2.0 Solves two word problems and states results: (a) finds the value of a part from the percent of total and value of total. (b) finds the percent one number is of another.	2.1 Solves a word problem for percent of a number 2.1.1 Solves numeric problems for percent of a number 2.2 Solves a word problem for percent one number is of another 2.2.1 Solves numeric problems for percent one number is of another	None	Brown, Snader, & Simon. General Mathematics Book 1. (USAFI D151/152). Part I, Chapter 5, pgs 227-231

TAIS No. 3006

MODULE GED
UNIT Percent Problems
TOPIC Basic Operations

CRITERION AND ENABLING OBJECTIVES

TASK IDENTIFICATION: 2.0

TASK ELEMENTS: 2.1 - 2.2
2.1.1 - 2.2.1

CRITERION OBJECTIVE(S)	ENABLING OBJECTIVE(S)
2.0 When presented word problems of two types, the student: (a) Solves for and STATES the value of a part, given value of the total and percent the part is of the total. (b) Solves for and STATES percent that a part is of the total, given values of the part and of the total.	2.1 In a word problem STATES value of a part, given percent part is of total and value of total. 2.1.1 STATES value of a part given explicit problems of the form--What is % of X? (given % and X). 2.2 In a word problem STATES percent part is of the total, given part value and total value. 2.2.1 STATES percent one number is of another, given explicit problems of the form -- What % is X of Y? (given X and Y).

TAIS No. 3006

MODULE GED
UNIT Percent Problems
TOPIC Basic Operations

TEST ITEMS

TASK IDENTIFICATION: 2.0

TASK ELEMENTS: 2.1 - 2.2
2.1.1 - 2.2.1

CRITERION ITEM(S)	ENABLING ITEM(S)
2.0 Solve this problem... When you take a test which consists of 120 problems and need to answer 65% of the questions correctly in order to pass, how many questions do you need to answer correctly? (78, .65*120, 65/100*120) Solve this problem... Your team won 7 of the 11 football games it played. What percent of the games played were won? (63.6, 63.64, 63.636, 64)	2.1 Joe saves 15% of his earnings from off-base jobs. If he earns $220 per month, how much does he save each month? ($33.00, 33 dollars, .15*220, 15/100*220) 2.1.1 Find the percent of each number. 10% of 80 = ? (8, 8.0) 4% of 150 = ? (6, 6.0) 12 1/2% of 60 = ? (7.5, 7.50) 3/4% of 240 = ? (1.8, 1.80) 300% of 62 = ? (186, 186.0) 2.2 Of the 200 students in the last entry-level tech training class, 180 completed and graduated. What percent graduated? (90%, 90 percent) 2.2.1 What percent is ( ) of ( )? What percent is 25 of 100? (25, 1/4) What percent is 30 of 6? (500) What percent is 7 of 25? (28) What percent is 25 of 7? (357, 357.14)

TAIS No. 3007

MODULE GED
UNIT Percent Problems
TOPIC Solving Word Problems

TRAINING ANALYSIS INFORMATION SHEET

1. TASK IDENTIFICATION: 3.0

2. TASK: Solves percent word problems of increasing difficulty for part values, total values, multiple part values and remainders, percent of parts, percent profit or loss, and prediscount prices.

3. CONDITIONS: Given four word problems with values for either part(s), total, or percent missing and to be found.

4. STANDARD: At least three correct answers on four criterion problems.

5. TASK ANALYSIS:

TASK ELEMENTS	SUB ELEMENTS	SUPPLEMENTAL TRAINING MATERIAL	REFERENCES
3.0 Solves four word problems of different types: (a) Finds percent profit from buying and selling prices (b) Finds percent value depreciation from original price and selling price (c) Finds original price from discount price and percent discount (d) Finds total wins from games scheduled and percents for losses, ties, no-shows	3.1 Identifies the part, total, or percent values given in word problems 3.2 Identifies in word problems which part, total, or percent is missing and to be found 3.2.1 Identifies key words denoting what the problem asks and the quantity asked for 3.3 States the math expression for word problem solution 3.3.1 Selects the math expression for word problem solution	None	U.S. Dept. of Labor, AGEP High School Self Study Program. Solving Percentage Word Problems. (PM 431-27), 1969 Hockett. GED Mathematics Home Study Guide. Barron's, 1972, Lessons 8 and 9 on Word problems UCMP Revision Project. How to Teach Students to Solve Math Story Problems (Draft). SDC, 1972

TAIS No. 3007 (contd.)

MODULE GED

UNIT Percent Problems

TOPIC Solving Word Problems

TRAINING ANALYSIS INFORMATION SHEET

1. TASK IDENTIFICATION: 3.0 (contd.)

2. TASK:

3. CONDITIONS:

4. STANDARD:

5. TASK ANALYSIS:

TASK ELEMENTS	SUB ELEMENTS	SUPPLEMENTAL TRAINING MATERIAL	REFERENCES
3.4 Performs arithmetic operations and states numeric answers for word problems	3.4.1 Finds a part value from total value and percent of total of the missing part 3.4.2 Finds a part value from total value and percent of total of a second part 3.4.3 Finds a new total from a part value and percent increase in relation to the current total 3.4.4 Finds individual part values and value of missing part from a total and percent of total for named parts.		

TRAINING ANALYSIS INFORMATION SHEET

1. TASK IDENTIFICATION: 3.0 (contd.)

2. TASK:

3. CONDITIONS:

4. STANDARD:

5. TASK ANALYSIS:

TASK ELEMENTS	SUB ELEMENTS	SUPPLEMENTAL TRAINING MATERIAL	REFERENCES
	3.4.5 Finds amount and percent of increase from bought and sold prices 3.4.6 Finds percent of total for a part from value of the other part and value of total 3.4.7 Finds original total from a reduced total and percent discount 3.4.8 Finds original total from a higher total and percent taxation		

TAIS No. 3007

MODULE GED

UNIT Percent Problems

TOPIC Solving Word Problems

CRITERION AND ENABLING OBJECTIVES

TASK IDENTIFICATION: 3.0

TASK ELEMENTS: 3.1 - 3.4
3.2.1 - 3.4.8

CRITERION OBJECTIVE(S)	ENABLING OBJECTIVE(S)
3.0 Solves and STATES answers for four word problems: (a) Solves for profit dollars and profit percent, given buying and selling prices (b) Solves for amount of dollar loss and percent value depreciation, given original price and selling price (c) Solves for original price, given sale price and percent discount (d) Solves for number of wins, given number of games scheduled and percent of losses, ties, and no-shows	3.1 Given a word problem to find the dollar value of a discount from the percent discount and pre-discount price, the student STATES the values for the two facts given, and... 3.2.1 ...IDENTIFIES what it is that is missing and to be found. 3.2.2 ...IDENTIFIES that it is 'part' missing (rather than total or percent). 3.3.1 ...SELECTS the correct math statement to solve the problem.
3.4 Given percent word problems of increasing difficulty (3.4.1-3.4.8) student performs the arithmetic operations and STATES a numeric answer with answer units.	3.3 Given a total and the percent total 3.4.1 of a part, student STATES the math statement to find the part value and STATES the value. 3.2 Given a total and the percent of one 3.3.1 part, student IDENTIFIES that a part 3.4.2 is missing, SELECTS one of two correct solutions, and STATES the value of the other part. 3.4.3 Given a part value and percent increase of that part for the total, student STATES the total. 3.4.4 Given a total and percent of total contributed by each of several parts, student finds and STATES individual part values and STATES a remainder.

CRITERION AND ENABLING OBJECTIVES

TASK IDENTIFICATION: 3.0 (contd.)

TASK ELEMENTS: 3.1 - 3.4
3.2.1 - 3.4.8

CRITERION OBJECTIVE(S)	ENABLING OBJECTIVE(S)
	3.4.5 Given a buying price and selling price, student finds and STATES amount of profit and percent of profit.
	3.3 3.4.6 Given a total value and value of one part, student STATES the math steps and percent of total of the other part.
	3.4.7 Given a reduced total and percent of discount, student STATES the percent paid and an original total.
	3.4.8 Given a taxed price and percent of taxation, student STATES the taxed percent and the pre-tax price.

TAIS No. 3007

MODULE GED

UNIT Percent Problems

TOPIC Solving Word Problems

TEST ITEMS

TASK IDENTIFICATION: 3.0

TASK ELEMENTS: 3.1 - 3.4
3.2.1 - 3.4.8

CRITERION ITEM(S)	ENABLING ITEM(S)
3.0 Let's see if you can solve the next four problems A used car dealer bought a car for $450 and then sold it for $500. What percent of the selling price was profit? (10%, 10 percent, .10) You buy a car for $2800. If you were to sell it again after one year and you got $2100 for the car, what would be the percent depreciation in value of the car? (25%, 25 percent, .25) The 'Fumblers', a local softball team, was scheduled to play 60 games last season. The team lost 55% of the games, tied 15%, and forgot to show up for 5%. They won the remaining games. How many games did they win? (15 games, 15) If the sale price of a television set after 25% reduction is $183, what was the original price of the set? ($244, 244 dollars, 244.00, 244)	3.1 Your best girl bought a $35 dress at a 25% discount. How much was the discount? Read the problem carefully. Find the facts. First...price of the dress before discount was ($?) ($35.00, $35, 35) Second...she saved (? %) of the original price. (25%, 25) 3.2.1 What is it you are looking for in this problem? A Amount of money she paid B Percent of discount C Amount of money she saved (C) 3.2.2 Is it part, total, or percent that is missing? (part) 3.3.1 Select the correct way to solve this problem A 25% * $35 (A) B $35/25% C $35 - ($35 * 25%) Now, give the answer ($8.75, 8.75)

MODULE GED

UNIT Percent Problems

TOPIC Solving Word Problems

TEST ITEMS

TASK IDENTIFICATION: 3.0 (contd.)

TASK ELEMENTS:

CRITERION ITEM(S)	ENABLING ITEM(S)
3.4 (See items 3.4.1-3.4.8.)	3.3 Fred has 75 coins in his collection. 3.4.1 12 percent are gold coins. How many coins are gold? Write the math statement that would give an answer to this problem. (Just use numbers and + - * or / on one line) (75 * .12, or equivalent math expression) Now, gold coins = ? (9, nine, niner) 3.2 A box of ammunition was found to 3.3.1 weigh 15% less than its marked 3.4.2 weight of 35 pounds. How much did the ammo box weigh? What is missing? Is it part, total, or percent you are to find? (part) This problem can be solved two ways. How would you solve this problem? (select one way) A Find 15% of 35 pounds. B Find 15% of 35 pounds and subtract that from 35 pounds. C Find 85% of 35 pounds. D None of these. (B, C) Now, how much did the box of ammo weigh? (29.75 pounds, 29.75) 3.4.3 Let's build you a word problem. How many pounds do you weigh? (enter a number) EXAMPLE: (155 pounds) By the end of your next vacation your weight will be 10% above your present weight of 155 pounds. How many pounds will you weigh then? EXAMPLE: (170.5 pounds, 170.5)

TAIS No. 3007 (cont.)

MODULE GED

UNIT Percent Problems

TOPIC Solving Word Problems

TEST ITEMS

TASK IDENTIFICATION: 3.0 (contd.)

TASK ELEMENTS:

CRITERION ITEM(S)	ENABLING ITEM(S)
	3.4.4 How much is your monthly Army pay before deductions? EXAMPLE: ($600) You earn $600 monthly. If 14% is deducted for income tax, 3% for the credit union, and 2 1/2% for savings bonds, what is your take-home pay? Let's get the dollar value of each part (each deduction). First, income tax = $? (at 14% of pay) (84) Credit union = $? (at 3% of pay) (18) Savings bonds = $? (at 2 1/2% of pay) (15) You earn $600 monthly. Your deductions are: Income Tax $84 Credit Union $18 Savings Bonds $15 Now, what would be your take-home pay? EXAMPLE: ($483, 483)
	3.4.5 A man you know buys a used radio set for $7.20. He repairs it and sells it for $18. What percent of his selling price is profit? Remember, Profit = Selling Price - Buying Price How much was the profit in this problem? ($10.80, 10.80) How do you find what percent is profit of the selling price? (10.80/18, 60%, 60)

TAIS No. 3007 (cont.)

MODULE GED

UNIT Percent Problems

TOPIC Solving Word Problems

TEST ITEMS

TASK IDENTIFICATION: 3.0 (contd.)

TASK ELEMENTS:

CRITERION ITEM(S)	ENABLING ITEM(S)
	3.3 In a class of 56 students, 7 are girls. 3.4.6 What percent of the students are boys? First, try to give the math steps for the answer. a) (7/56) That will give percent girls. What is the next step? (100 - 12.5) That's the last step. Now, answer = ? (87.5%, 87.5 percent) b) (56 - 7) That will give number of boys. What is the next step? (49/56) That's the last step. Now, answer = ? (87.5%, 87.5 percent) 3.4.7 You pay $63 for a suit that was reduced by 10%. What was the regular price? You paid 100% - 10% = ? % (90) Now, what was the regular price? ($70, 70 dollars, 70.00, 70) 3.4.8 Your buddy wants to buy a car that costs $2500. This price includes a 20% state tax. How much would this car cost without the tax? With the tax, your buddy will pay 100% + 20% = ? (120) Now, how much would the car cost without the tax? (2,084, 2084, 2083, 2,083, 2083.33, 2,083.33, 2500/1.20, 250000/120)

MODULE GED
UNIT Interpreting Data

4. Interpreting Data

CONTENT DEVELOPMENT

Subject Matter Outline	General Task/Objective
I. Grouping Data	1.0 Determines interval ranges and midpoints; tallies frequency counts for intervals.
A. Utility for summarizing a number of data items; overall shape of grouped data has meaning.	1.1.1 Names a descriptive phrase as that for "interval".
B. Concept of "intervals" for grouping; guidelines for setting-up intervals:	1.1.2 Names a descriptive phrase as that for "frequency table".
1. determine range of data = largest value - smallest value	1.1.3 States the minimum and maximum number of intervals generally used for grouping.
2. choose interval size to get about 10-20 intervals	1.1.4 Orders set of ungrouped data and gives range for each set.
3. start lowest interval with multiple of interval size just below smallest data value	1.2 Fills-in frequency counts for all intervals by tallying data items.
C. Concept of "frequency distribution"; setting-up a frequency table. Example of unordered data from MOS set up as frequency table:	1.2.1 Fills-in missing frequencies by tallying data.

Interval	Tally	Freq.
70-74	X	1
65-69	XXX	3
60-64	XXXXXX	6
.	.	.
.	.	.
.	.	.

D. Exact limits of intervals. Whole and decimal explication of limits shown by example; e.g., 48-50 = 47.5 - 50.5

CONTENT DEVELOPMENT (Cont'd)

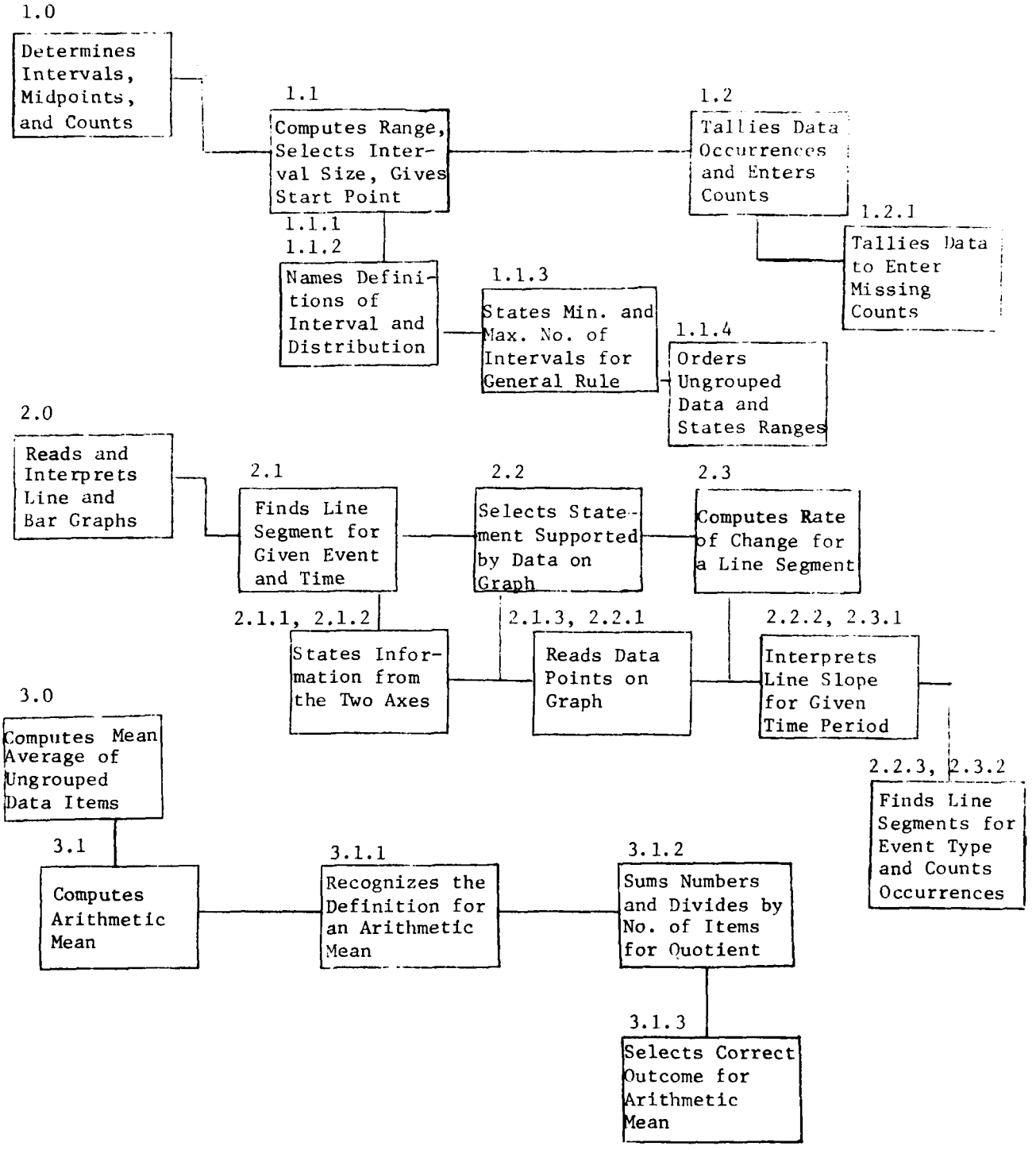
Subject Matter Outline	General Task/Objective
II. Reading Graphs	
A. Learning goals for graphs and averages. Utility for reading news and magazines.	2.0 Reads data, interpret trends, and calculates conclusions from line and bar graphs.
B. Bar graphs (student uses first handout, Figure 1)	2.1 Finds line segment for an event and its duration of occurence.
1. Information from the title	2.1.1 Finds and states information from 2.1.2 two axes of graph.
2. What is shown by scales at left and at bottom	2.2 Selects a statement directly justifiable by graph.
3. Reading information from height of bars	2.1.3 Reads data points on graph trend 2.2.1 line.
4. Reading information from lateral balance of bars (shape of the graph)	2.3 Computes rate of change for a line segment over a stated period of time.
C. Line graph (student uses second handout, Figure 2)	2.2.2 Interprets slope of line segment 2.3.1 for a given time period.
1. Identifying information on the scales	2.2.3 Finds line slope for a stated 2.3.2 type of event and counts number of occurrences.
2. Changes over time a "trend line"	
3. Utility of line versus bar	
4. Reading line along vertical scale	
5. Reading line along horizontal scale	
6. Finding highest and lowest points on trend line	

MODULE GED
UNIT Interpreting Data

CONTENT DEVELOPMENT (Cont'd)

Subject Matter Outline	General Task/Objective
II. Reading Graphs (Cont'd)	
7. Comparing slopes of line segments for information	
8. Comparing number of directional changes for information	
9. Selecting conclusions directly supported by graph	
10. Slope of line and computed conclusions (rate of change)	
III. Computing an Average	3.0 Calculates the arithmetic mean for ungrouped data in a word problem.
A. Common meaning of average	
B. Definition of "mean" average	3.1 Computes the mean of ungrouped data items.
C. Sample problem worked and tryout problem for student	3.1.1 Selects among definitions to find the definition for the arithmetic mean.
D. Summing an unordered set of whole or decimal numbers and dividing by the number of values	3.1.2 Obtains a quotient by summing values and dividing by the number of values.
E. Review of computational steps	3.1.3 Selects among problem outcomes the correct value for an arithmetic mean.
F. Drill and practice problems	

TASK HIERARCHY



TAIS No. 3008

MODULE GED

UNIT Interpreting Data

TOPIC Grouping Data

TRAINING ANALYSIS INFORMATION SHEET

1. TASK IDENTIFICATION: 1.0

2. TASK: Determines interval ranges and midpoints for unordered data and tallies frequency of occurrence for each interval.

3. CONDITIONS: Given an unordered list of comparable values.

4. STANDARD: No errors on criterion problem.

5. TASK ANALYSIS:

TASK ELEMENTS	SUB ELEMENTS	SUPPLEMENTAL TRAINING MATERIAL	REFERENCES
1.0 Determines interval ranges and midpoints, and tallies frequency counts for these intervals	1.1 Computes the range of a set of unordered data; selects size and number of intervals; specifies start point of lowest interval 1.1.1 States interval as the name for a category in which to group data 1.1.2 States frequency distribution as naming the tally of data occurrences in several intervals 1.1.3 States the maximum and minimum number of intervals generally used for grouping data 1.1.4 Orders and states ranges for sets of ungrouped data 1.2 Fills-in frequencies for intervals by tallying unordered data items	None	Brown, Snader, & Simon. General Math, Book 1, (USAFI D151/152) 1968, pgs 244-57 Final Report: Computer Based Instruction in Statistical Inference. SDC, 1967 Instructional Objectives Exchange. Math: Data Relationships. 1972, pgs 75-80

TAIS No. 3008 (contd.)

MODULE GED
UNIT Interpreting Data
TOPIC Grouping Data

TRAINING ANALYSIS INFORMATION SHEET

1. TASK IDENTIFICATION: 1.0

2. TASK:

3. CONDITIONS:

4. STANDARD:

5. TASK ANALYSIS:

TASK ELEMENTS	SUB ELEMENTS	SUPPLEMENTAL TRAINING MATERIAL	REFERENCES
	1.2.1 Fills-in missing frequencies by tallying unordered data		

TAIS No. 3008

MODULE GED

UNIT Interpreting Data

TOPIC Grouping Data

CRITERION AND ENABLING OBJECTIVES

TASK IDENTIFICATION: 1.0

TASK ELEMENTS: 1.1 - 1.2
1.1.1 - 1.2.1

CRITERION OBJECTIVE(S)	ENABLING OBJECTIVE(S)
1.0 Given a list of comparable unordered data, student will set-up and STATE the interval ranges and midpoints, and STATE the frequency count for each interval	1.1 Given a list of unordered data, student will STATE the range, SELECT an interval size, and STATE the start point of the lowest interval 1.1.1 Given a descriptive phrase, student NAMES it as "interval" 1.1.2 Given a descriptive phrase, student NAMES it as "frequency distribution" 1.1.3 Given an incor 'ete sentence, FILL-IN the maximum and minimum number of intervals generally used to group data 1.1.4 Given four sets of numbers, student ORDERS each set by increasing value and STATES the range of the set 1.2 Given a list of comparable unordered whole number values and intervals, student will count data occurrences and FILL-IN the tally for each interval 1.2.1 Given unordered data and the frequency count for one interval missing, student will count data occurrences and FILL-IN the missing tally

TEST ITEMS

TASK IDENTIFICATION: 1.0

TASK ELEMENTS: 1.1 - 1.2
1.1.1 - 1.2.1

CRITERION ITEM(S)	ENABLING ITEM(S)
1.0 Now, here's the test scores you saw earlier (display 1.1 scores again). We're going to let you fill-in this table using an interval size of 3. Interval / Midpoint / Frequency . . . . Just start with the lowest interval and go to the highest, completing one line at a time. Answer: Interval / Midpoint / Frequency 18-20 / 19 / 2 21-23 / 22 / 1 24-26 / 25 / 1 27-29 / 28 / 2 30-32 / 31 / 5 33-35 / 34 / 6 36-38 / 37 / 4 39-41 / 40 / 1 42-44 / 43 / 2 45-47 / 46 / 2 48-50 / 49 / 1	1.1 Assume that the following are your test scores: 50 33 19 31 46 31 31 37 34 45 30 20 33 43 28 34 34 38 42 27 22 36 40 26 37 32 35 What is the range of this set of scores? (31) How many intervals would you use to group scores above? (11, within 1) What interval size would you select? (3, within 1) Where would you begin the first interval using an interval size of 3? (18, 17.5) 1.1.1 When dealing with unordered values, it sometimes is helpful to group the data. These groups are called? (Intervals, class intervals) 1.1.2 Suppose that several scores or other kind of values have been grouped into intervals and the number of scores in each interval has been recorded. This describes a (Frequency distribution, freq dist, frequency table) 1.1.3 In general, data values should be grouped into no less than (10, ten) intervals, and no more than (20, twenty)

TAIS No. 3008 (cont.)

MODULE GED

UNIT Interpreting Data

TOPIC Grouping Data

TEST ITEMS

TASK IDENTIFICATION: 1.0

TASK ELEMENTS: 1.1 - 1.2
1.1.1 - 1.2.1

CRITERION ITEM(S)	ENABLING ITEM(S)
	1.1.4 You will see four sets of numbers. Put each list in order of increasing value, left-to-right, and then give me the range when I ask for it. First set, 75, 85, 70, 72, 89, 72, 58, 59, 95, 99 (Order: 58, 59, 70, 72, 72, 75, 85, 89, 95, 99) Range = (41) Next set, 1.3, 11, 101.29, 109, 1, 0, 15 (Order: 0, 1, 1.3, 11, 15, 101.29, 102.09, 109) Range = (109) Third set, .10, 1.01, 9.90, .001, .99, 9.10 (Order: .001, .10, .99, 1.01, 9.10, 9.90) Range = (9.899) Last set, .95, .010, .600, .094, .00019 (Order: .00019, .010, .094, .600, .95) Range = (0.94981) 1.2 The number of rounds fired on the mortar range each day during the month of August was as follows: 82 71 84 78 73 65 98 94 78 63 94 93 76 72 95 81 75 79 (Continued on next page)

TAIS No. 3008 (cont.)

MODULE GED

UNIT Interpreting Data

TOPIC Grouping Data

TEST ITEMS

TASK IDENTIFICATION: 1:0

TASK ELEMENTS: 1.1 - 1.2
1.1.1 - 1.2.1

CRITERION ITEM(S)	ENABLING ITEM(S)
	1.2 (cont.) The following is an incomplete frequency table with intervals of 10. You fill-in the frequency count for each interval.

Interval	Midpoint	Frequency
55-64	60	(1)
65-74	70	(4)
75-84	80	(8)
85-94	90	(3)
95-104	100	(2)

1.2.1 The daily temperature highs in Los Angeles for the first half of August two years ago were as follows:

82 87 92 84 83
84 85 81 78 74
76 84 86 90 94

Here they are set up in intervals of 5 degrees between interval midpoints.

Interval	Midpoint	Frequency
73-77	75	2
78-82	80	
83-87	85	7
88-92	90	
93-97	95	1

Give me the missing frequencies.
78-82 = (3) 88-92 = (2)

TRAINING ANALYSIS INFORMATION SHEET

1. TASK IDENTIFICATION: 2.0

2. TASK: Reads and intreprets bar and line graphs; identifies trends and significance of points on the line graph; computes a conclusion from information shown on the line graph.

3. CONDITIONS: Given two figures: (1) a bar graph showing how students scored on a test; (2) a line graph showing atmospheric pressure readings over time.

4. STANDARD: No more than one error in three criterion questions.

5. TASK ANALYSIS:

TASK ELEMENTS	SUB ELEMENTS	SUPPLEMENTAL TRAINING MATERIAL	REFERENCES
2.1 Finds line segment for an event and its duration of occurrence 2.2 Discriminates among five statements to find only one directly supported by the graph 2.3 Computes a conclusion on rate of change from information presented.	2.1.1 Reads the trend line in relation to the vertical scale. 2.1.2 Reads the trend line in relation to the base scale. 2.1.3 Reads the left-most 2.2.1 axis at apex of trend line/bar 2.2.2 Interprets direction- 2.3.1 al slope of line for a given time period. 2.2.3 Finds slope of line 2.3.2 for a type of occurrence and counts number of occurrences	Figure 1 - Bar graph (not shown) Figure 2 - Line graph superimposed on a lighter bar graph (not shown)	GED Test Form J June 1969 Instructional Objectives Exchange. Math: Data Relationships, 1972. Graphs, pgs 41-49 Hockett, S.O. GED Math Home Study Guide. Barron's 1972, pgs 218-226 Brown, Snader, & Simon. General Math, Book 1, (USAFI D151/152), 1968, Chapter 6, pgs 259-272

MODULE GED

UNIT Interpreting Data

TOPIC Reading Graphs

CRITERION AND ENABLING OBJECTIVES

TASK IDENTIFICATION: 2.0

TASK ELEMENTS: 2.1-2.3
2.1.1-2.3.2

CRITERION OBJECTIVE(S)	ENABLING OBJECTIVE(S)
2.0 Given a line graph showing atmospheric pressure plotted over time, the student:	
2.1 Correctly selects the longest time duration during which atmospheric pressure increased.	2.1.1 Given a line graph showing atmospheric pressure plotted over time, student student STATES the range of the pressure readings.
2.2 SELECTS one of five statements directly justified by the graph (by interpreting only information presented by the graph).	2.1.2 Given the 2.1.1 graph, student SELECTS the range of time covered by the pressure trend line. 2.1.3 Given the same graph as 2.1.1, the 2.2.1 student SELECTS the time at which the maximum pressure reading was recorded.
2.3 Computes and STATES from a given number of hours the rate of atmospheric pressure decrease in centimeters per hour.	2.2.2 Given the 2.1.1 graph and a time 2.3.1 period, the student STATES that the pressure was decreasing. 2.2.3 Given the 2.1.1 graph and instructions 2.3.2 to find the number of time periods in which pressure was rising, (and falling), the student STATES correct counts of one-hour or half-hour periods.

TAIS No. 3009

MODULE GED

UNIT Interpreting Data

TOPIC Reading Graphs

TEST ITEMS

TASK IDENTIFICATION: 2.0

TASK ELEMENTS: 2.1-2.3
2.1.1-2.3.2

CRITERION ITEM(S)	ENABLING ITEM(S)
2.0 A 'line graph' is most useful to show changes and comparisons in something over time. Figure 2 shows a line graph. A bar graph is also shown in lighter lines. The line graph shows atmospheric pressure readings taken at a weather station over a continuous period of time. Every half hour the pressure is measured in 'centimeters' of mercury and recorded on the graph. 2.1 Over what length of time did the longest continuous rise in pressure occur? (E) A 1 hour B 1 1/2 hours C 2 hours D 2 1/2 hours E None of these	2.1.1 Find the top and bottom points on the line graph. The pressure readings range from (?) to (?) centimeters of mercury. (73.5 77, 77 73.5) 2.1.2 Now find the points furthest to the left and to the right on the trend line. The trend line covers how many hours (to the nearest half-hour)? (C) A 10 B 11 C 11 1/2 D 12 2.1.3 The pressure reached a high of 77.0 2.2.1 at about what time? (C) A 1030 B 1500 C 1530 D 1600 2.2.2 From 1530 until 1830, the pressure 2.3.1 was...? (falling, dropping, decreasing, less, fell, dropped, down) 2.2.3 How many times did the pressure rise 2.3.2 between 0700 and 1830? (3, three, 12, twelve) How many times did the pressure fall? (4, four, 11, eleven)

TEST ITEMS

TASK IDENTIFICATION: 2.0 (contd.)

TASK ELEMENTS: 2.1 - 2.3
2.1.1 - 2.3.2

CRITERION ITEM(S)	ENABLING ITEM(S)
2.0 (contd.) 2.2 Which, if any, of the following statements is justified by the information on the line graph. (B) A During the total period the pressure was increasing rapidly less than half the time. B The pressure increased at about the same rate throughout all of the rising periods. C Temperature changes occurred at different times during the afternoon. D Recordings were made at sea level. E None of the above. 2.3 At about what rate in centimeters per hour over a 3-hour period did the pressure drop from the maximum height to the minimum height recorded? (1.16, 1.17, 1.1666)	

MODULE GED

UNIT Interpreting Data

TOPIC Computing an Average

TRAINING ANALYSIS INFORMATION SHEET

1. TASK IDENTIFICATION: 3.0

2. TASK: Calculates the arithmetic mean of unordered and ungrouped data.

3. CONDITIONS: Given a word problem with 8 unordered whole numbers

4. STANDARD: No errors.

5. TASK ANALYSIS:

TASK ELEMENTS	PREREQUISITE KNOWLEDGE OR SKILL REQUIREMENTS	SUPPLEMENTAL TRAINING MATERIAL	REFERENCES
3.1 Computes the mean of 8 ungrouped data items.	3.1.1 Recognizes the definition of an arithmetic mean of ungrouped data 3.1.2 Sums whole and decimal numbers and divides by the number of items to obtain a quotient 3.1.3 Selects correct numeric outcome for the arithmetic mean of ungrouped data	None	GED Test, Form J, 1969. Final Report: Computer Based Instruction in Statistical Inference. SDC, 1967 Brown, Snader, & Simon. General Math, Book 1. (USAFI D151/152) 1968, Chapter 6, pg 250-258 Instructional Objectives Exchange. Math Data Relationships, 1972. Statistics, pg 80-83

CRITERION AND ENABLING OBJECTIVES

TASK IDENTIFICATION: 3.0

TASK ELEMENTS: 3.1 - 3.3
3.1.1 - 3.3.1

CRITERION OBJECTIVE(S)	ENABLING OBJECTIVE(S)
3.1 Given an unordered set of whole number data items in a word problem, student COMPUTES and STATES an average.	3.1.1 Given statements defining the mode, mean, and median, student SELECTS the one for computing the mean average. 3.1.2 Given an unordered set of whole and decimal numbers, student STATES the sum and STATES a quotient for sum ÷ no. of items. 3.1.3 Given an unordered set of whole numbers in a word problem and three arithmetic outcomes based upon these items, student SELECTS the numeric outcome for the arithmetic mean.

TAIS No. 3010

MODULE GED

UNIT Interpreting Data

TOPIC Computing an Average

TEST ITEMS

TASK IDENTIFICATION: 3.0

TASK ELEMENTS: 3.1 - 3.3
3.1.1 - 3.3.1

CRITERION ITEM(S)	ENABLING ITEM(S)
3.1 The temperature readings for certain hours on a particular day are shown below in degrees: 2, 1, 4, 12 24, 39, 28, 36 What is the mean average of these readings? (18.25)	3.1.1 Select the statement which describes the method for computing the 'mean' average. (C) A The most frequently occurring number in a set of numbers B The number above which and below which one-half of the set of numbers fall C The sum of all values divided by the total number of values summed D None of the above 3.1.2 Now, give the sum of all the following numbers. 109 11 15.5 17.6 .010 99 1.4 2.09 Sum = ? (255.6, 255.60) Now, divide this sum by the number of items and give your answer. (31.95) 3.1.3 The following were the hits by each of ten riflemen firing 20 rounds each 3 11 9 2 6 18 14 17 8 9 The average number of hits for the 10 riflemen was...? (C) A 10.0 B 9.5 C 9.7 D 9.0

5. Using Algebra

CONTENT DEVELOPMENT

Subject Matter Outline	General Task/Objective
I. Algebraic Symbols and Vocabulary	1.0 Gives solution set for variables in math sentences.
A. Preview	1.1 States if math sentences are true or false when numbers from replacement set are substituted into sentences.
1. Same equation used to solve three different word problems	1.2 Differentiates solution sets from replacement sets.
2. Analogy of English sentences reduced to tight, concise math sentences.	1.3 Identifies equivalent forms of the same operations.
B. Review meaning of operators +, -, *, /, **	1.4 Identifies meanings of operations and relational symbols.
C. Meaning of relationals = > <	
D. Meaning of variable or "general number" as a placeholder in "open sentences."	
e.g., F = 9/5 C + 32 C = 2πR I = PRT W = RM 33/3 = ? ?*.02 = 2 4X-2 = 10	
E. Truth or falsity of math sentences drill.	
1. Replacement set as any suitable numbers.	
2. Solution set as those numbers making equation a true statement.	
F. Equivalent forms of expressing operations, e.g., 3*Y = (3) (Y) = 3Y = 3(Y), or X = 1X	

CONTENT DEVELOPMENT (Cont'd.)

Subject Matter Outline	General Task/Objective
II. Basic Expressions	2.0 Writes component expressions for a word problem.
A. Algebraic expression or word phrase is a meaningful group of symbols; e.g.,	2.1 Differentiates monomial, binomial, and polynomial expressions.
R-5 means..... 5 subtracted from R R minus 5 R diminished by 5 5 less than R R less 5 R takeaway 5 R decreased by 5, etc.	2.2 Identifies all terms in expressions.
B. Terms in expressions	2.3 Gives numeric coefficients of terms in expressions.
1. Parts connected by arithmetic operation symbols	2.4 Matches expressions with equivalent word phrases.
a. Monomials have 1 term, e.g., 8, X^2, 3Y, Z, 4X/Y	
b. Binomials have 2 terms; e.g., X+3, Y-4, 4X-2, P+I, 2P+3Q	
c. Polynomials have 2 or more terms, e.g., P+I, X+3, $3X^2$ - X+4, so binomials are also polynomials.	
2. Numerical coefficients of terms are numbers preceding letters in a term; e.g., 3 in 3Y.	

CONTENT DEVELOPMENT (Cont'd)

Subject Matter Outline	General Task/Objective
III. Grouping Symbols	3.0 Evaluates numeric expressions with and without grouping symbols.
Purpose: parentheses make order of operations explicit in an algebraic expression.	3.1 Performs operations in correct order according to operations and grouping symbols.
A. Implicit operations. Rule: move left-to-right, doing first, all exponentiation; second, all multiplication and division; third, all addition and subtraction. e.g., 3 + 4*5 means (4*5) + 3.	3.1.1 Evaluates an expression containing nested grouping symbols. 3.2 Finds a unique result by evaluating similar expressions.
B. Explicit parentheses overrides implicit rule. Rule: Do operations in parentheses first, then go to implicit rule. e.g., (3 + 4)*5 means 7*5	3.1.2 3.2.1 Rewrites expressions to obtain desired results.
C. Explicit nested parentheses. Rule: Do operations in inside parentheses first, working outwards, e.g., 3 + (5(3-1) + 4 = 3 + (5 + 2 + 4) = 3 + 11 = 14	3.1.3 3.2.2 Completes a rule on order of operations with nested parentheses. 3.1.4 3.2.3 Evaluates simple numeric expressions with nested parentheses. 3.1.5 3.2.4 Completes a rule on order of operations with one pair of parentheses. 3.1.6 3.2.5 Evaluates simple numeric expressions with single sets of parentheses.

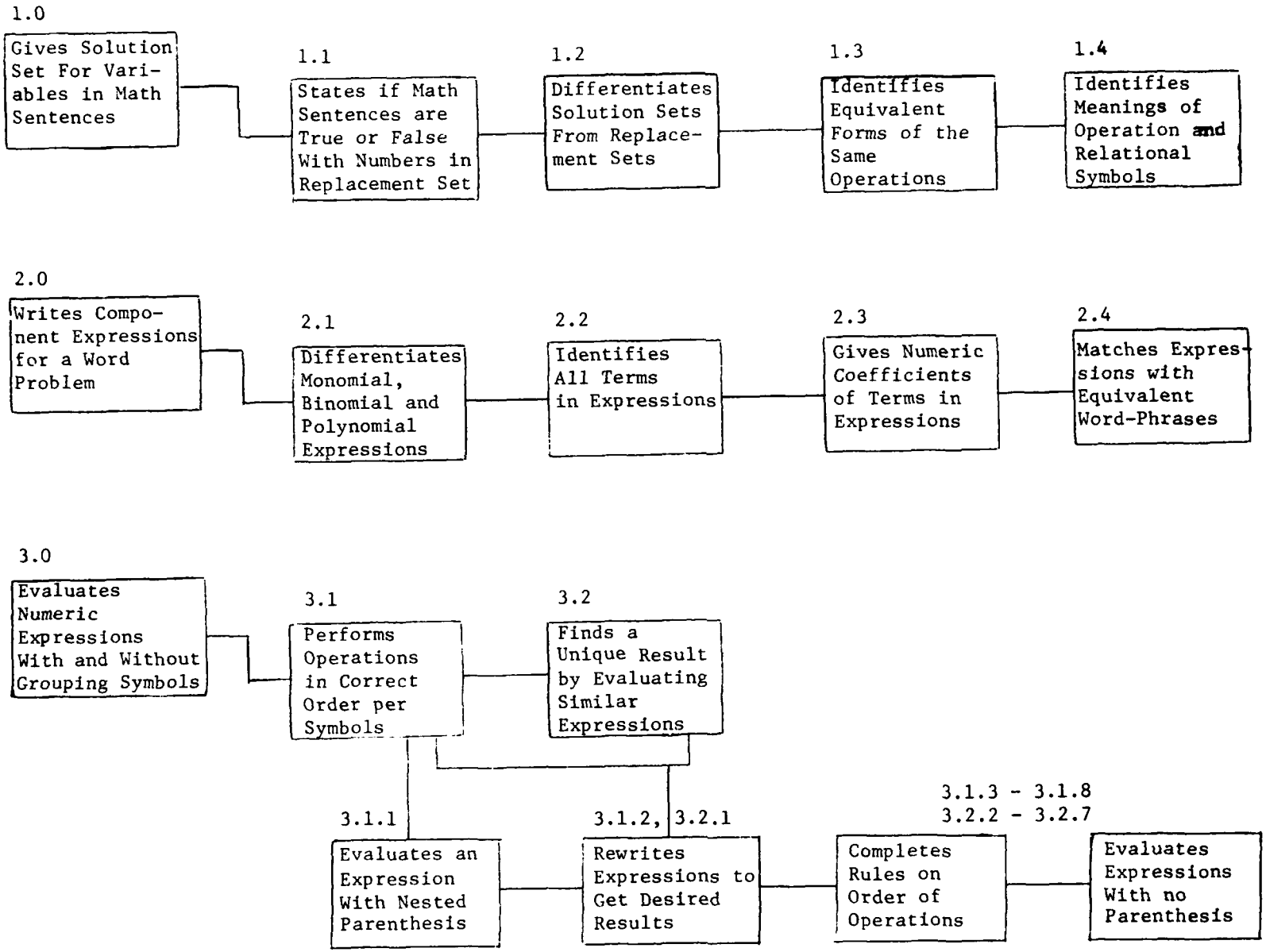
CONTENT DEVELOPMENT (Cont'd)

Subject Matter Outline	General Task/Objective
	3.1.7 3.2.6 Completes a rule on order of operations with no grouping symbols.
	3.1.8 3.2.7 Evaluates simple numeric expressions with no parentheses.
IV. Words as Algebraic Expressions	4.0 Writes algebraic expressions for simple word problems.
A. Practice in translating three types of word statements into algebraic form:	4.1 Writes expressions as solution statements.
1. Statements describing numeric relations.	4.1.1 Selects expressions as word problem solutions.
2. Statements describing monetary and measurement relations.	4.1.2 Writes expressions for numeric relations.
3. Statements describing part-whole relations.	4.1.3 Writes expressions for measurement and monetary relations.
	4.1.4 Writes expressions for part-whole relations.
B. Contrasting meaning of = symbol in equations and in fractions or formulas.	4.2 Writes simple equations and functions for word phrases.
1. Equivalence	4.2.1 Selects words where = means equivalence.
2. Dependence or relationship	4.2.2 Selects words where = means dependence.
C. Practice in writing solution statements for word problems.	

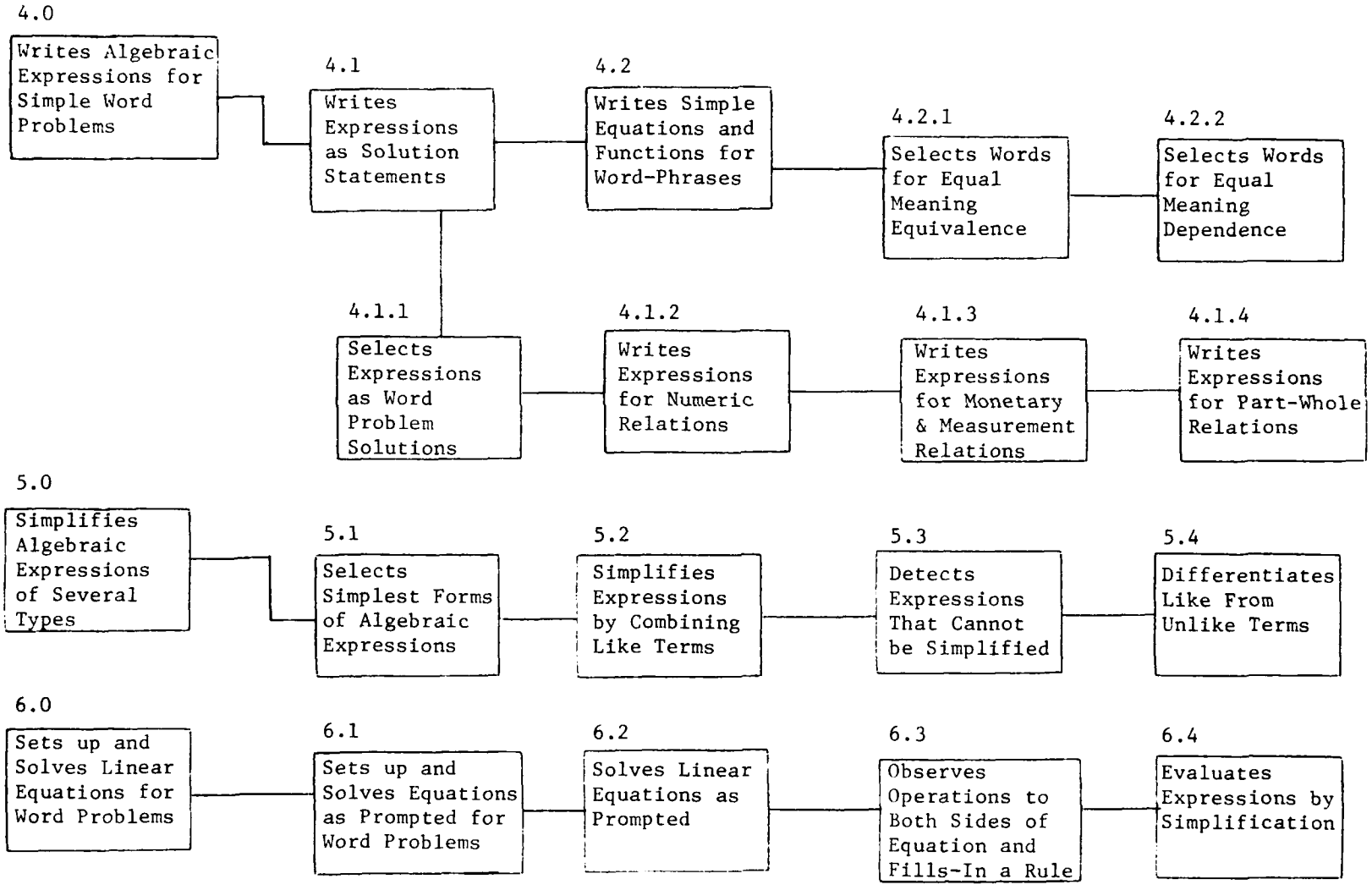
CONTENT DEVELOPMENT (Cont'd)

Subject Matter Outline	General Task/Objective
V. Simplifying Expressions	5.0 Simplifies algebraic expressions varying by signs, operations, and grouping symbols.
A. Combining like terms e.g., 3 + 2 are like A + 2A are like BC + BD are unlike $X^2 + X^3$ are unlike	5.1 Selects simplest forms of algebraic expressions.
	5.2 Simplifies expressions by combining like terms.
B. Like terms are collected first and combined to simplify expression: $X^2+2X+6X+5+3X^2-5X+2$ $= (X^2+3X^2)+(2X+6X-5X)+(5+2)$ $= 4X^2+3X+7$	5.3 Detects expressions that cannot be simplified. 5.4 Differentiates like from unlike terms.
VI. Solving Word Problems	6.0 Sets up and solves linear equations for word problems.
A. Order of steps.	6.1 Sets up and solves equations as prompted for word problems.
1. State given and unknown	6.2 Solves linear equations as prompted for numeric problems.
2. Write solution equation	6.3 Observes operations to both sides of an equation and completes a rule.
3. Substitute values for variables	6.4 Evaluates expressions by simplification.
4. Simplify	
5. Perform inverse operations to both sides	
6. Solve by performing arithmetic operations	
B. Equivalent equations by same operation to each side.	
Student gives numbers to add, subtract, multiply, divide to both sides of equation. System displays equivalence.	

TASK HIERARCHY



TASK HIERARCHY (Cont'd)



TAIS No. 3011

MODULE GED

UNIT Using algebra

TOPIC Symbols and Vocabulary

TRAINING ANALYSIS INFORMATION SHEET

1. TASK IDENTIFICATION: 1.0

2. TASK: States the solution set for variables in open mathematical sentences

3. CONDITIONS: Given a replacement set and 5 math sentences.

4. STANDARD: 4 correct in 5 sentences

5. TASK ANALYSIS:

TASK ELEMENTS	SUB ELEMENTS	SUPPLEMENTAL TRAINING MATERIAL	REFERENCES
1.0 States the solution set for each sentence in a set of open math sentences.	1.1 States whether numbers from a replacement set make open math sentences true or false. 1.2 Differentiates solution sets from replacement sets. 1.3 Identifies equivalent representations of the same arithmetic operation. 1.4 Matches select arithmetic operation and relational symbols with their meanings.	None	Hockett, S. GED Math Home Study Guide Barron's, 1972 Lesson 10

CRITERION AND ENABLING OBJECTIVES

TASK IDENTIFICATION: 1.0

TASK ELEMENTS: 1.1-1.4

CRITERION OBJECTIVE(S)	ENABLING OBJECTIVE(S)
1.0 Given a replacement set of six whole numbers for 5 open sentences, student will determine and STATE the solution set of numbers for each sentence.	1.1 Given open math sentences and selected numbers from the replacement set for each sentence, student STATES whether the sentence is true or false. 1.2 Given open math sentences and a list of number sets, student will DIFFERENTIATE solution sets from replacement sets and STATE the solution sets. 1.3 Given expressions showing equivalent and non-equivalent operations, student will IDENTIFY those expressions denoting equivalent operations. 1.4 Given the symbols (=, +, -, *, /, **, >, <) student will MATCH them with their meanings.

TAIS No. 3011

MODULE GED

UNIT Using algebra

TOPIC Symbols and Vocabulary

TEST ITEMS

TASK IDENTIFICATION: 1.0

TASK ELEMENTS: 1.1-1.4

CRITERION ITEM(S)	ENABLING ITEM(S)
1.0 Let (0, 1, 2, 3, 4, 5) be the replacement set for the following math sentences. Find and give me all the numbers in this set for which each math sentence is true (state none, if no numbers make the sentence true). X >2 (3,4,5) X+1=4 (3) Y-3=0 (3) Z+4=1 (none) Y+1<5 (0, 1, 2, 3)	1.1 I will show you an open sentence and one or more numbers from the replacement set. You tell me if the numbers are in the solution set by indicating if the sentence is "true" or "false". Y > 2 (0, 1, 2) T/F? (F) Y > 2 (3, 4) T/F? (T) 2+X=2 (2, 3) T/F? (F) Y+1<5 (5) T/F? (F) Z+4=1 (4, 5) T/F? (F) 2+X=2 (0) T/F? (T) 1.2 See if any sets of numbers on the left are solution sets for expressions on the right. Set / Expression A. (0, 1, 2, 3, 4, 5) 1. Y< 4 B. (3, 4, 5) 2. X+1=4 C. (2) 3. Y=2 D. (0, 1, 2, 3) 4. Y+3=5 Match letters with numbers to give me just the solution sets (C3, C4, D1)

TAIS No. 3011 (contd.)

MODULE GED

UNIT Using algebra

TOPIC Symbols and Vocabulary

TEST ITEMS

TASK IDENTIFICATION: 1.0

TASK ELEMENTS: 1.1-1.4

CRITERION ITEM(S)	ENABLING ITEM(S)
	1.3 Which of the expressions below show the same operation? (list the letters) (A, C, D, E) A. 3*Y B. 3/Y C. (Y)(3) D. 3 x Y E. 3(Y) F. all are the same Is X = 1X true? (Yes/No) (YES) 1.4 Match the algebraic symbols on the left with their meanings on the right. = (7) 1. not equal to + (6) 2. less than - (3) 3. subtract ** (8) 4. multiply * (4) 5. not less than / (10) 6. add > (9) 7. equals < (2) 8. raise to power 9. greater than 10. divide

TAIS No. 3012

MODULE GED

UNIT Using algebra

TOPIC Basic algebraic expressions

TRAINING ANALYSIS INFORMATION SHEET

1. TASK IDENTIFICATION: 2.0

2. TASK: Student can write component algebraic expressions for solving a word problem

3. CONDITIONS: Given a three-question word problem

4. STANDARD: No errors for each component expression

5. TASK ANALYSIS:

TASK ELEMENTS	SUB ELEMENTS	SUPPLEMENTAL TRAINING MATERIAL	REFERENCES
2.0 Writes one binomial and two monomial expressions to answer each of three questions in a word problem.	2.1 Differentiates monomial, binomial and polynomial expressions. 2.2 Identifies all terms in expressions. 2.3 States numerical coefficients for terms in expressions. 2.4 Matches expressions with word-phrases equivalent in meaning.	None	Hockett, S. GED Math Home Study Guide Barron's, 1972 Lesson 10

CRITERION AND ENABLING OBJECTIVES

TASK IDENTIFICATION: 2.0

TASK ELEMENTS: 2.1-2.4

CRITERION OBJECTIVE(S)	ENABLING OBJECTIVE(S)
2.0 Given a three-question word problem and prompts for each expression, student will STATE algebraic expressions to answer each question.	2.1 Given six expressions, one at a time, NAMES them as monomial, binomial and/or polynomial by typing, M, BP, or P. 2.2 Given three expressions, one at a time, STATES the terms in each expression. 2.3 Given three expressions, STATES the numerical coefficients of all terms. 2.4 Given an expression, CLASSIFIES whether each in a series of word-phrases is/is not equivalent in meaning to the expression.

TEST ITEMS

TASK IDENTIFICATION: 2.0

TASK ELEMENTS: 2.1-2.4

CRITERION ITEM(S)	ENABLING ITEM(S)
2.0 Jane's age is 2 years less than four times Sarah's age. How old was Sarah 5 years ago? How old will Sarah be in 10 years? How old is Jane? Expression for Sarah's age 5 years ago = (X-5) Expression for Sarah's age in 10 years = (X+10) Expression for Jane's age = (4X-2)	2.1 Tell me whether each of these expressions is a monomial, binomial and/or polynomial by typing 'M', 'BP' and 'P'. X+Y+Z (P) P+1 (BP) 3Y (M) 4X/Y (M) 4X-2 (BP) 3X**2-X+4 (P) 2.2 Write the terms in the following expressions (use commas between terms). X+10 (X, 10) X**3 (X**3) 3X-4Y+5Z (3X, 4Y, 5Z)

TEST ITEMS

TASK IDENTIFICATION: 2.0

TASK ELEMENTS: 2.1-2.4

CRITERION ITEM(S)	ENABLING ITEM(S)
	2.3 Write the coefficients for terms in the following expressions (use commas between). 5xy (5) -2A (-2) 3X**2-X (3, 1) 2.4 Type "Yes" or "No" to tell me if the words which follow mean the same as this expression R-5 5 increased by R (Y/N) (N) 5 less than R (Y) R take away 5 (Y) 5 decreased by R (N) What about this expression? 4X-2 (4 times X) minus 2 (Y) the product of 4 and X, less 2 (Y) 2 more than 4 multipled by X (N)

MODULE GED

UNIT Using algebra

TOPIC Order of Operations

TRAINING ANALYSIS INFORMATION SHEET

1. TASK IDENTIFICATION: 3.0

2. TASK: Student evaluates explicit numeric expressions with and without grouping symbols

3. CONDITIONS: Given numeric expressions involving addition, subtraction, multiplication, division and exponentiation

4. STANDARD: At least four correct of 6 criterion problems

5. TASK ANALYSIS:

TASK ELEMENTS	SUB ELEMENTS	SUPPLEMENTAL TRAINING MATERIAL	REFERENCES
3.1 Performs arithmetic operations in correct order in numeric expressions with and without grouping symbols. 3.2 Selects among similar expressions with and without parentheses the one giving a different result.	3.1.1 Evaluates an expression with nested parentheses by giving steps. 3.1.2 Writes expressions 3.2.1 with grouping symbols from expressions with no grouping symbols and desired numeric results. 3.1.3 Completes a rule on 3.2.2 order of operations with nested parentheses. 3.1.4 Evaluates simple 3.2.3 numeric expressions with nested parentheses. 3.1.5 Completes a rule on 3.2.4 order of operations with one pair of parentheses.	None	Final Report Computer Based Instruction in Statistical Inference SDC, 1967

MODULE GED

UNIT Using algebra

TOPIC Order of Operations

TRAINING ANALYSIS INFORMATION SHEET

1. TASK IDENTIFICATION: 3.0

2. TASK:

3. CONDITIONS:

4. STANDARD:

5. TASK ANALYSIS:

TASK ELEMENTS	SUB ELEMENTS	SUPPLEMENTAL TRAINING MATERIAL	REFERENCES
	3.1.6 Evaluates simple 3.2.5 numeric expressions with one set of parentheses. 3.1.7 Completes a rule on 3.2.6 order of operations with no grouping symbols. 3.1.8 Evaluates simple 3.2.7 numeric expressions with no parentheses.		

TAIS No. 3013

MODULE GED

UNIT Using algebra

TOPIC Order of Operations

CRITERION AND ENABLING OBJECTIVES

TASK IDENTIFICATION: 3.0

TASK ELEMENTS: 3.1-3.1.8
3.2-3.2.7

CRITERION OBJECTIVE(S)	ENABLING OBJECTIVE(S)
3.1 Given a set of 5 expressions involving operations of addition, subtract, multiplication, division and exponentiation -- with and without grouping symbols -- student will STATE his whole number answers.	3.1.1 Given a numeric expression with nested parentheses, student will evaluate the expression by STATING his four steps and his answer.
3.2 Given four expressions involving the same operations, and coefficients, with and without parentheses, student will CHOOSE the one giving a result different than the other three.	3.1.2 Given numeric expressions with no 3.2.1 parentheses involving addition, subtraction, multiplication, division, or exponentiation, and given the results desired from evaluating the expressions, student will WRITE the expression with parentheses to get the desired results.
	3.1.3 Given a rule for expansion of nested 3.2.2 grouping symbols, student FILLS-IN that operations on "inside" parentheses are done first.
	3.1.4 Given two numeric expressions with 3.2.3 nested parentheses involving addition and subtraction, student STATES numeric answers.
	3.1.5 Given a rule regarding expressions 3.2.4 with one pair of grouping symbols, student FILLS-IN that operations inside the parentheses are done "first".
	3.1.6 Given two numeric expressions each 3.2.5 with one set of parentheses, student STATES numeric answers.
	3.1.7 Given a rule regarding expressions 3.2.6 with no grouping symbols, student FILLS-IN "**" as the operation done first, "+" or "-" coming after multiply or divide.
	3.1.8 Given three numeric expressions each 3.2.7 with no parentheses, student STATES numeric answers.

TEST ITEMS

TASK IDENTIFICATION: 3.0

TASK ELEMENTS: 3.1-3.1.8
3.2-3.2.7

CRITERION ITEM(S)	ENABLING ITEM(S)
3.1 As each of the next expressions appear, perform the operations called for and give your answers. 2+6/2=(5) (2+3)**3=(125) 3*2**2+6*5-10=(32) 5+7*2-4**2/8=(17) 100-(((3+2)**2-10)*4)+6/3=(42)	3.1.1 Remember that raising to a power ** is performed first, before * or /. Try this one, showing me the steps as you evaluate. 1+(((3+2)**2-10)*4) Step 1 = 1+((5**2-10)*4) Step 2 = 1+((25-10)*4) Step 3 = 1+(15*4) Step 4 = 1+60 Answer = 61
3.2 Which one of these four expressions will produce different results from the other three? (with no rounding off) a. (5**2+2**2+7**2)/3 * b. (5**2)+(2**2)+(7**2)/3 c. 5*5/3+2*2/3+7*7/3 d. (1/3)*(5+5+2*2+7*7)	3.1.2 In the next items, you will be given 3.2.1 an expression and a desired outcome. Your job is to retype the expression so that the desired result is computed. For example: Expression: 3+4*5+7 — Desired Result: 84.0 You would have to type (3+4)*(5+7) Now...start at the top and take one expression at a time:

Expression	Desired Result	Answer
3+4*5+7	42.0	(3+4)*5+7
3/5+7	7.60	3/5+7
3/5+7	0.250	3/(5+7)
17+3/5	4.0	(17+3)/5

TEST ITEMS

TASK IDENTIFICATION: 3.0

TASK ELEMENTS: 3.1-3.1.8
3.2-3.2.7

CRITERION ITEM(S)		ENABLING ITEM(S)
Expression	Desired Result	Answer
3-6/2+7+49	51.333	3-6/(2+7)+49
2+2**2	6.0	2**2+2 or (2**2)+2
2+2**2	16.0	2**(2+2)
3+6/3**3	125.0	(3+6/3)**3
3+6/3**2	1.0	(3+6)/3**2

3.1.3 When two or more pair of grouping
3.2.2 symbols appear in an expression, perform operations on the numbers in the (inside, innermost) parentheses first.

3.1.4 Work these out and give me your
3.2.3 answers:

2+(6-(3+1)+4)=(8)

3+(5+(3-1)+4)=(14)

3.1.5 If one pair of grouping symbols are
3.2.4 present, the operation inside will be performed _____.

* a. first

b. after any raising to a power outside the parentheses

c. after any multiplication or division

d. none of these

TEST ITEMS

TASK IDENTIFICATION: 3.0

TASK ELEMENTS: 3.1-3.1.8
3.2-3.2.7

CRITERION ITEM(S)	ENABLING ITEM(S)
	3.1.6 Work these out and give your 3.2.5 answers: (6+4)/2=(5) 6+(4/2)*3=(12) 3.1.7 If there are no grouping symbols, 3.2.6 then ... enter symbol or words (**, exponentiation, power) comes first, followed by multiplying or dividing. Multiplication and divisions have priority over (addition subtraction, + -) and (subtraction addition, - +). 3.1.8 These should be easy for you to 3.2.7 evaluate. As each expression appears, work out your answer and type it. 8*2+3=(19) 8+4/2=(10) 3*2**4+6=(54)

MODULE GED

UNIT Using algebra

TOPIC Words as algebraic expressions

TRAINING ANALYSIS INFORMATION SHEET

1. TASK IDENTIFICATION: 4.0

2. TASK: Writes algebraic expressions, equations, or functions for simple word problems

3. CONDITIONS: Given word problems with the variable letter(s) stated in the words.

4. STANDARD: No errors

5. TASK ANALYSIS:

TASK ELEMENTS	SUB ELEMENTS	SUPPLEMENTAL TRAINING MATERIAL	REFERENCES
4.1 Writes expressions as solution statements for word problems. 4.2 Writes simple equations and functions for word statements.	4.1.1 Selects expressions as solutions to word problems 4.1.2 Writes expressions for statements describing numeric relationships 4.1.3 Writes expressions for statements describing monetary and measurement quantities 4.1.4 Writes expressions for statements describing part-number relations 4.2.1 Selects words which give meaning of equivalence to = symbol 4.2.2 Selects words which give meaning of dependence to = symbol	None	Brown, Snader, & Simon General Math, Book 1 (USAFI D151/152) 1968. pgs 305-315 Hockett, S. Math Home Study Guide Barron's, 1972 Lesson 10 pgs 163-165

CRITERION AND ENABLING OBJECTIVES

TASK IDENTIFICATION: 4.0

TASK ELEMENTS: 4.1-4.1.4
4.2-4.2.2

CRITERION OBJECTIVE(S)	ENABLING OBJECTIVE(S)
4.1 Given three word problems containing letters for the unknowns, student WRITES algebraic expressions as problem solution statements.	4.1.1 Given two word problems, student CHOOSES the correct expressions for solution from among several expressions.
4.2 Given three statements of relationship containing letters for the unknowns, student WRITES equations or functions, as appropriate to describe the relationships.	4.1.2 Given word-phrases denoting numeric relationships, student WRITES algebraic expressions describing the phrases.
	4.1.3 Given word-phrases denoting monetary and measurement units, student WRITES algebraic terms describing these phrases.
	4.1.4 Given word-phrases denoting part-number relationships, student WRITES algebraic expressions describing these phrases.
	4.2.1 Given a list of words denoting 4.2.2 equivalence or dependence, student IDENTIFIES which words denote equivalence and which denote dependence.

TAIS No. 3014

MODULE GED

UNIT Using algebra

TOPIC Words as algebraic expressions

TEST ITEMS

TASK IDENTIFICATION: 4.0

TASK ELEMENTS: 4.1-4.1.4
4.2-4.2.2

CRITERION ITEM(S)	ENABLING ITEM(S)
4.1 Show the algebraic sentences for solving each of the following problems: A car travels Y miles per hour. The distance traveled by the car in Z hours is? YZ, Y(Z), (Y)(Z), Y*Z Your friend bought a suit for Y dollars. The sales tax rate on the purchase was 3%. The sales tax was? .03Y, .03(Y), (.03)(Y), Y*.03 You want to buy 3 ties at X dollars each. The change you would receive from a $20 bill would be? 20-3X, 20-3*X, 20-3(X)	4.1.1 A sweater costs $18. The cost of C sweaters is _____ 18+C 18/C C/18 * 18C C-18 Bill had Y dollars. He bought A things at B dollars each. The amount of money he had left over was _____ AB-Y AB+Y * Y-AB Y/AB ABY 4.1.2 Try to write algebraic expressions for these English phrases: Two less than half of P (1/2 P-2, .5P-2, P/2-2) X divided by the sum of X and 3 X/X+3) A number that X exceeds by 1 X-1 Twice the sum of P and Q 2(P+Q) 10 gallons at Q cents per gallon 10Q, 10(Q), 10*Q, (10)(Q). 34% of the sum of R and S .34(R+S)

TEST ITEMS

TASK IDENTIFICATION: 4.0

TASK ELEMENTS: 4.1-4.1.4
4.2-4.2.2

CRITERION ITEM(S)	ENABLING ITEM(S)
	4.1.3 Write algebraic terms for these phrases. The number of ... Cents in D dimes (10D) Cents in M dollars (100M) Feet in Y yards (3Y) Feet in M miles (5280M)
	4.1.4 Now write algebraic expressions for these phases: George's age three years ago if he is now Y years old (Y-3) Emanual's weight if it exceeds Pete's by W and Pete weighs 150 (150+W) The amount of money earned by Filipe if he and Sal together earned $75 and Sal earned D dollars (75-D)
4.2 Write an equation or a function expressing each of the following (use X on the first one). If 4 times the number is increased by 3 *it is the same as* 2 *less than* 5 times the number (4X+3=5X-2). The perimeter of a square (P) will vary in relation to four times the length of one of its sides (S) (P=4S). The circumference of a circle (C) changes as twice the radius (R) times 3·14 (C=2*3·14*R)	4.2.1 4.2.2 Look at the following words and phrases. If they would translate into an = sign meaning "equals", type E. If they would translate into an = sign meaning "is a function of", type F. Depends (F) Is (E) Same as (E) Related (F) Are (E) Relation (F) Will be (E) Was (E) Vary (F) Changes (F)

CRITERION AND ENABLING OBJECTIVES

TASK IDENTIFICATION: 5.0

TASK ELEMENTS: 5.1-5.4

CRITERION OBJECTIVE(S)	ENABLING OBJECTIVE(S)
5.0 Given three algebraic expressions with negative terms, terms in parentheses, and terms with like and unlike exponents, student simplifies the expressions and WRITES their simplest forms.	5.1 Given three expressions, one at a time, student SELECTS the simplest form of the expression from a list. 5.2 Given three simple expressions, student combines like terms and STATES the simplified expression. 5.3 Asked which of several expressions can be simplified, student STATES that none can be simplified. 5.4 Given several sets of terms, student SELECTS which sets are "like" terms.

MODULE GED
UNIT Using algebra
TOPIC Simplifying expressions

TRAINING ANALYSIS INFORMATION SHEET

1. TASK IDENTIFICATION: 5.0

2. TASK: Simplifies algebraic expressions by combining like terms

3. CONDITIONS: Given three expressions with negative terms, terms in parentheses, and terms with like and unlike exponents.

4. STANDARD: Two of three criterion expressions correct. Error acceptable in third expression only.

5. TASK ANALYSIS:

TASK ELEMENTS	SUB ELEMENTS	SUPPLEMENTAL TRAINING MATERIAL	REFERENCES
5.0 Simplifies algebraic expressions requiring the application of several rules in combining like terms.	5.1 Selects the simplest forms of three expressions, one of which cannot be simplified. 5.2 Simplifies basic expressions by combining like terms. 5.3 Detects expressions which cannot be simplified. 5.4 Differentiates sets of like terms from sets of unlike terms.	None	Hockett, S. GED Math Study Guide Barron's, 1972 Lesson 10 pgs 165-166 Dept. of Labor AGEP Self-Study Program: Algebra. 1969

TEST ITEMS

TASK IDENTIFICATION: 5.0

TASK ELEMENTS: 5.1-5.4

CRITERION ITEM(S)	ENABLING ITEM(S)
5.0 Simplify each of the following algebraic expressions to its simplest form: 5A-3B-A+4B+4 (4A+B+4) (4A)+(-5A)-(10A) (-11A) 3XY-5X**2Y+2XY**2-XY+X**2Y (2XY-4X**2Y+2XY**2)	5.1 You will see three expressions. Choose the simplest form from this list. a. 4X**2+3X+7 b. 4X**2+7X+7 c. 4X-2X d. 2X e. Cannot be simplified First ... 4X-X-X (d) Now ... X**2+2X (e) Last ... X**2+2X+6X+5+3X**2-5X+2 (a) 5.2 Simplify these expressions by combining like terms. 2·4A-1·8A (.6A) 8T-3T+T (6T) 2X-Y+3X+4Y (5X+3Y) 5.3 Which of these expressions if anv can be simplified (None) 2A+3B X**2+2X X**2+X**3

TEST ITEMS

TASK IDENTIFICATION: 5.0

TASK ELEMENTS: 5.1-5.4

CRITERION ITEM(S)	ENABLING ITEM(S)
	5.4 Here are several sets of terms. Tell me which sets are "like terms" by typing the letters a, c, d, g * a. X**2, 3X**2 b. X**2, X * c. 5, 2 * d. B, 3B, 6B e. 3X, 3 f. AB, AC, AD * g. 2X, 6X, -5X

MODULE GED

UNIT Using algebra

TOPIC Solving word problems

TRAINING ANALYSIS INFORMATION SHEET

1. TASK IDENTIFICATION: 6.0

2. TASK: Sets up and solves linear equations for word problems

3. CONDITIONS: Given two word problems

4. STANDARD: No errors

5. TASK ANALYSIS:

TASK ELEMENTS	SUB ELEMENTS	SUPPLEMENTAL TRAINING MATERIAL	REFERENCES
6.0 Solves two GED-type word problems by constructing and evaluating linear equations.	6.1 Constructs and evaluates equation for a word problem when prompted for each step. 6.2 Evaluates linear equations when prompted for each step. 6.3 Evaluates an equation and completes a rule from observing the same operations applied to both sides of the equation. 6.4 Evaluates three expressions by simplification.	None	Hockett, S. GED Math Study Guide Barrons, 1972 Lesson 10 pgs. 168-176 GED Test Form J, 1969 Dept. of Labor AGEP Self-Study Program: Algebra 1969

CRITERION AND ENABLING OBJECTIVES

TASK IDENTIFICATION: 6.0

TASK ELEMENTS: 6.1-6.4

CRITERION OBJECTIVE(S)	ENABLING OBJECTIVE(S)
6.0 Given two word problems solvable as linear equations, student sets-up and evaluates equations and STATES the answers.	6.1 Given a word-problem to solve for X, and given prompts for each step, student WRITES the equation at each step and STATES the answer. 6.2 Given two numeric equations to evaluate for X and, given prompts for each step, student WRITES the equation at each step and STATES the answer. 6.3 Given an equation to solve for X -- and a number provided by the student which is added, subtracted, multiplied, and divided on both sides of the equation -- the student STATES the numeric outcome for each case, CONFIRMS that the equality remains unchanged in all cases, and FILLS-IN a rule. 6.4 Given three expressions to evaluate and the values for the variables, student evaluates the expressions by simplification and STATES the outcomes.

TEST ITEMS

TASK IDENTIFICATION: 6.0

TASK ELEMENTS: 6.1-6.4

CRITERION ITEM(S)	ENABLING ITEM(S)
6.0 When you solve the next two problems, you qualify for GED algebra. A wooden beam is 58 inches long. A carpenter must cut the beam so that the longer part is 8 inches longer than the shorter part. How long is the shorter part? (25) Answer should be derived as follows: X+(X+8) = 58 2X = 58-8 X = 25 inches or X+X+8-8 = 58-8 2X = 50 X = 25 inches In basketball, a foul basket counts 1 point and a field basket counts 2 points. A team scored 73 points, making 8 more field baskets than foul baskets. How many foul baskets did they make? (19) Answer should be derived as follows: B+2(B+8) = 73 B+2B+16 = 73 3B = 57 B = 19 foul baskets	6.1 If 5 years from now, your son will be 14 years old, how old is he now? (Don't do this by subtraction) First, using X for your son's current age, what is the equation? (X+5=14) Now, write the equation with the subtraction shown on both sides (X+5-5=14-5) Finally, your answer X = (9) 6.2 Solve for X by evaluating the next two equations using inverse operations. First ... X-2=6 Show inverse operations (X-2+2=6+2) Answer, X = (8) Now solve ... X+2X+X-2=10 Simplify (4X-2=10) Show inverse (4X-2+2=10+2) Evaluate (4X=12) Answer, X = (3)

TEST ITEMS

TASK IDENTIFICATION: 6.0

TASK ELEMENTS: 6.1-6.4

CRITERION ITEM(S)	ENABLING ITEM(S)
	6.3 Here is an equation 4X = 12 Give me a number from 1 to 4 and I will add, subtract, multiply, and divide both sides of the equation by the number. Number = 2 (for example) Adding 4X+2 = 12+2 4X = 12 Subtracting 4X-2 = 12-2 4X = 12 Multiplying 4X*2 = 12*2 8X = 24 Dividing 4X/2 = 12/2 2X = 6 In each case, solving for X gives (3) Does performing the same operation to both sides change the equality shown by the equation? (yes/no) (No) Now, complete this rule ... When the same number is used for addition, subtraction, multiplication, division or raising to a power on (both, 2, two) sides of the equation, the (equality) of the equation stays the same. 6.4 Evaluate the expressions which follow, using these values for variables. X = 5 Y=4 Z=3 A=2 B=1 The value of 2X**2+3Y = (62) The value of 3X+5A-7B = (18) The value of A**2/Y+2XZ = (31)

APPENDIX B

RATING MATERIALS FOR USAFI REVIEW OF GED AI MATH TRAINING ANALYSIS

- Subject Areas for GED Math
- Mathematics Rating Scale

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SUBJECT AREAS FOR GED MATH

		Typical GED Weightings
I	General Mathematics	50% - 62%
	A. Whole numbers: Review/applications	
	B. Fractions: Review/applications	
	C. Decimals: Review/applications	
	D. Percentages: Review/applications to finance, taxes, buying, wages	
	E. Reading graphs: Bar, line, circle	
	F. Constructing graphs	
	G. Computing averages: Mean, medium, mode	
	H. Metric geometry: Area	
	I. Metric geometry: Volume	
II	Algebra	35% - 25%
	A. Symbols and conventions	
	B. Evaluating explicit expressions with and without grouping symbols	
	C. Evaluating expressions with variables	
	D. Equations, formulas, and functions	
	E. Monomials	
	F. Polynomials	
	G. Products and factoring	
	H. Graphing linear and selected equations	
	I. Systems of equations	
	J. Exponents	
	K. Scientific notation	
	L. Progressions and series	
III	Plane Geometry	15% - 13%
	A. Points, lines and planes	
	B. Realtionships between lines and angles	
	C. Triangles: congruencies, inequalities	
	D. Similar polygons	
	E. Circles, arcs, and angles	
	F. Constructions and loci	
	G. Trigonometry	
	H. Logic and proof: Pythagorean theorem	

MATHEMATICS RATING SCALE

System Development Corporation (SDC) is working on a research project for the Army Research Institute (ARI) to determine the feasibility of using tactical computers for training and education. Enlisted personnel at Ft. Hood, Texas, will be given the opportunity to improve their ability to solve mathematics problems through use of the computer. A strategic set of GED mathematics subject areas are to be chosen for this experimental purpose. The training session for each student will be 3 to 4 hours in length.

Please rate each of the following subject areas in terms of its suitability for use in the research described above. Remember, we need to select areas where improvement can reasonably be expected to occur. Place an "X" on the line that best indicates your feeling about the suitability of each subject area.

GED MATHEMATICS SUBJECT AREAS

Highly Suitable		So-So		Not Suitable	I. GENERAL MATHEMATICS
___	___	___	___	___	A. Whole numbers: Review/ applications
___	___	___	___	___	B. Fractions: Review/ applications
___	___	___	___	___	C. Decimals: Review/ applications
___	___	___	___	___	D. Percentages: Review/ applications to finance, taxes, buying, wages
___	___	___	___	___	E. Reading graphs: bar, line, circle
___	___	___	___	___	F. Constructing traphs
___	___	___	___	___	G. Computing averages: Mean, median, mode
___	___	___	___	___	H. Metric geometry: Area
___	___	___	___	___	I. Metric geometry: Volume

Highly Suitable		So-So		Not Suitable	
____	____	____	____	____	A. Symbols and conventions
____	____	____	____	____	B. Evaluating explicit expressions with and without grouping symbols
____	____	____	____	____	C. Evaluating expressions with variables
____	____	____	____	____	D. Equations, formulas, and functions
____	____	____	____	____	E. Monomials
____	____	____	____	____	F. Polynomials
____	____	____	____	____	G. Products and factoring
____	____	____	____	____	H. Graphing linear and selected equations
____	____	____	____	____	I. Systems of equations
____	____	____	____	____	J. Exponents
____	____	____	____	____	K. Scientific notation
____	____	____	____	____	L. Progressions and series

II. ALGEBRA

Comments:

Cautions:

Highly Suitable			So-So	Not Suitable	
____	____	____	____	____	A. Points, lines and planes
____	____	____	____	____	B. Relationships between lines and angles
____	____	____	____	____	C. Triangles: congruencies, inequalities
____	____	____	____	____	D. Similar polygons
____	____	____	____	____	E. Circles, arcs, and angles
____	____	____	____	____	F. Constructions and loci
____	____	____	____	____	G. Trigonometry
____	____	____	____	____	H. Logic and proof: Pythagorean theorem

III. PLANE GEOMETRY

Comments:

Cautions:

AUTOMATED INSTRUCTION MODULES

Highly Suitable		So-So		Not Suitable	
____	____	____	____	____	I. DECIMALS
____	____	____	____	____	A. Place values
____	____	____	____	____	B. Rounding-off decimals
____	____	____	____	____	C. Basic decimal operations
					D. Solving decimal word problems

Comments:

Cautions:

Highly Suitable		So-So		Not Suitable	
____	____	____	____	____	II. PERCENTAGE PROBLEMS
____	____	____	____	____	A. Equivalency of fractions, ratios, decimals and percents
____	____	____	____	____	B. Basic operations: simple word problems
					C. Steps to solving GED-type percentage problems

Comments:

Cautions:

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Highly Suitable		So-So		Not Suitable	III. INTERPRETING DATA
___	___	___	___	___	A. Grouping data
___	___	___	___	___	B. Reading graphs
___	___	___	___	___	C. Computing an average

Comments:

Cautions:

Highly Suitable		So-So		Not Suitable	IV. USING ALGEBRA
___	___	___	___	___	A. Algebraic symbols and vocabulary
___	___	___	___	___	B. Basic expressions
___	___	___	___	___	C. Grouping symbols
___	___	___	___	___	D. Words as algebraic expressions
___	___	___	___	___	E. Simplifying expressions
___	___	___	___	___	F. Solving word problems

Comments:

Cautions:

APPENDIX C

INTRODUCTORY LESSON FOR THE AI GROUP

APPENDIX CONTENTS

This Appendix contains a listing of the introductory lesson that was developed to familiarize AI subjects with the types of questions being asked in the courses and the various methods of responding.

```
INTRO          AB

1 1.00 0
2THIS IS AUTOMATED INSTRUCTION BROUGHT TO YOU BY
2THE U. S. ARMY RESEARCH INSTITUTE AND THE
2SYSTEM DEVELOPMENT CORPORATION. BEFORE WE BEGIN
2THERE ARE A FEW RULES OR CONVENTIONS TO LEARN SO
2THAT YOU CAN TALK TO THE COMPUTER WHICH WILL
2MONITOR YOUR PROGRESS. PROVIDE ADDITIONAL
2INSTRUCTION WHEN NECCESSARY AND KEEP TRACK OF HOW
2WELL YOU ARE DOING.
2YOU WILL SEE THE WORDS (TYPE *GO* TO CONTINUE)
2AT THE BOTTOM OF THE SCREEN. SIMPLY TYPE THE
2LETTERS *G* AND *O* (GO) ON YOUR KEYBOARD AND
2THEN PRESS THE BLACK KEY MARKED *SEND* ON THE TOP
2RIGHT SIDE OF THE KEYBOARD. PRESS IT ONLY ONCE.
2ALSO MAKE SURE YOU TYPE THE LETTER *O* NOT THE
2NUMBER *0* (ZERO).
2      (TYPE *GO* TO CONTINUE)
30 WAIT 45
3R GO
3A GO
4 C:SET TOT=1 C:SET SAV=0 C:SET SAV=TIME
4A F:FINE. HERE'S THE NEXT ITEM.
4B F:YOU TYPED LETTER *O*, NUMBER *0* (ZERO). TRY
4F:AND BE MORE CAREFUL WHEN YOU ARE TAKING THE
4F:LESSONS.
4-*F:PLEASE TYPE *GO* AND PRESS THE BUTTON
4R:MARKED *SEND* ON YOUR KEYBOARD.
1 2.00 M
2YOU WILL BE ASKED VARIOUS KINDS OF QUESTIONS
2THROUGHOUT YOUR COURSE. ONE OF THESE WILL BE
2MULTIPLE CHOICE QUESTIONS. HERE YOU ARE EXPECTED
2TO TYPE IN THE LETTER WHICH HAS THE RIGHT ANSWER
2AND PRESS THE SEND KEY. FOR THE FOLLOWING
2QUESTION, DO THIS.
2WHAT NUMBER COMES AFTER FOUR>
3  A. 3
3  B. 2
3  C. 5
3  D. 6
4A RINO. 3 COMES BEFORE 4. WHAT COMES AFTER 4>
4B RINO. TRY AGAIN.
4C F:RIGHT. LET'S GO ON.
4RD F:NO. YOU SHOULD HAVE ENTERED THE
4F:LETTER *C* TO INDICATE THE ANSWER *5*.
1 3.00 Q
2ANOTHER TYPE QUESTION WILL GIVE YOU THE CHOICE OF
2ANSWERS IN PARENTHESES. LET'S TAKE THE SAME
2QUESTION AND ASK IT LIKE THIS. THE NUMBER THAT
2COMES AFTER FOUR IS (THREE) (FIVE). HERE YOU ARE
2EXPECTED TO TYPE THE CORRECT ANSWER, THREE OR
2FIVE, AND THEN PRESS THE SEND KEY. PLEASE DO
2THIS NOW.
3* FIVE
3R THREE
3C 5
```

```
#INTRO
30 3
31+5
32 3
4A F:GREAT, LET*S GO ON.
4RC2 F:YOU TYPED IN THE ANSWER O.K., BUT NOT
4F:THE RIGHT ONE. ENTER THE WORD THREE OR
4P:FIVE THIS TIME.
4-F:PLEASE TYPE IN *THREE* OR *FIVE* AS YOUR
4R:RESPONSE. DO THIS NOW.
4C1 F:YOU HAVE THE *RIGHT* NUMBER BUT WE WANTED
4F:YOU TO ENTER THE WORD--FIVE.
4-F:NO, WE WANTED YOU TO ENTER THE WORD *FIVE*.
1 4.00 Q
2THIS ONE IS MORE DIFFICULT TO DO. WE WILL GIVE
2YOU A SCRAMBLED LIST AND ASK YOU TO PUT THEM IN
2THE RIGHT ORDER. THE QUESTION MIGHT BE: PLACE
2THE FOLLOWING IN NUMERICAL ORDER FROM THE LOWEST
2TO THE HIGHEST
2  A. 4
2  B. 3
2  C. 5
2YOU WOULD TYPE IN YOUR ANSWER AS FOLLOWS: B A C
2AND THEN PRESS THE SEND KEY. PLEASE DO THIS NOW.
3A+B A C
3B+BAC
3C+B,A,C
3C+B, A, C
4A F:GREAT, LET*S GO ON
4B F:YOU TYPED IT IN O.K., BUT DIDN*T LEAVE THE
4R:SPACE BETWEEN THE LETTERS. TRY AGAIN.
4C R:NO COMMAS PLEASE. TRY AGAIN.
4-F:TYPE THREE LETTER*S TO SHOW THE ORDER OF THREE
4R:NUMBERS, LOWEST TO HIGHEST.
4F:NO, YOU SHOULD HAVE ENTERED THE LETTERS--B A C
1 5.00 M
2IF YOU HAVE TROUBLE DURING THE COURSE, JUST RAISE
2YOUR HAND AND SOMEONE WILL HELP YOU.
2READ THE QUESTIONS CAREFULLY AND ANSWER THEM ONLY
2IN THE WAY YOU ARE ASKED TO DO SO.
2NOW TO GET STARTED WITH THE LESSONS, ENTER THE
2LETTER THAT MATCHES THE COURSE TO WHICH YOU HAVE
2BEEN ASSIGNED.
3     A. CREW-SERVED WEAPONS (CAW)
3     B. TACTICS
3     C. SEE WITH
4A F:HERE IS YOUR FIRST LESSON. C:SET TOT=TIME-SAV
4  C:GOTO CAW1
4H F:HERE IS YOUR FIRST LESSON. C:SET TOT=TIME-SAV
4  C:GOTO INDIV1
4C F:THERE ARE SEVERAL OTHER THINGS TO NOTE BEFORE
4F:WE START THE MATH LESSONS.
1 5.50 Q
2IN THE MATH LESSONS A  >  IS OFTEN USED TO TELL
2YOU WHERE TO RESPOND WITH A NUMBER  LINE...V
2                5 1/4 = > DECIMAL
```

```
2vMEANS TO GIVE THE DECIMAL NUMBER FOR 5 1/4.
2   FOR  5 1/4 = >  YOU WOULD ANSWER  5.25
2(TYPE ≠GO≠ TO CONTINUE)
3A GO
4-A F:SOMETIMES THE HELP GIVEN YOU ON A MATH
4F:PROBLEM OR EXAMPLE WILL BE BRIEF.  LIKE....
1 5.50 Q
2                  10/5 = 2 * 100 =200  v
2MEANS...          10 DIVIDED BY 5 GIVES 2
2  AND...           2 TIMES 100 GIVES 200
2v(TYPE ≠GO≠ WHEN READY)
30 WAIT 240
3A GO
4-A F:THERE ARE TWO ADDITIONAL THINGS TO BE
4F:CAREFUL ABOUT IN THE MATH LESSONS.
1 6.00 Q
2IT IS VERY IMPORTANT THAT YOU USE THE NUMBER
2ZERO (0) WHEN YOU ARE TYPING NUMBERS AND NOT THE
2LETTER O.  ONE WAY TO TELL THE  ZERO (0) KEY IS
2THAT THE ZERO (0) HAS A SLASH (/) THROUGH IT,
2LIKE THIS--Ø.  WHEREAS THE LETTER O DOESN≠T.
2ALSO, YOU MUST BE CAREFUL NOT TO USE THE COMMA
2(,) WHEN YOU MEAN TO USE THE DECIMAL POINT OR
2PERIOD (.)   NOTE THAT THESE TWO KEYS ARE NEXT
2TO EACH OTHER.  SO, WHEN ENTERING NUMBERS MAKE
2SURE THAT THE DECIMAL POINT AND COMMA IS IN THE
2CORRECT PLACE.  FOR EXAMPLE:
2            6.100.05 OR JUST 6100.05 ARE CORRECT
2BUT NOT     6,100.05 v
2       (NOW TYPE ≠GO≠ TO START THE LESSONS)
30 WAIT 240
3A GO
4-A C:SET TOY=TIME-SAV C:TO TO DEC)
4≠R:TYPE ≠GO≠ TO CONTINUE.
$$$$$$
```

APPENDIX D

ORIENTATION BRIEFING FOR MASSTER TEST 122

APPENDIX CONTENTS

This Appendix contains the orientation briefing given each test day to those subjects who were participating in MASSTER Test 122.

ORIENTATION - MASSTER TEST 122

GOOD MORNING, GENTLEMEN. I'M GOING TO GIVE A GENERAL ORIENTATION TO MASSTER TEST 122. THE OFFICIAL TITLE OF THE TEST IS THE INTEGRATED BATTLEFIELD CONTROL SYSTEM AUTOMATED INSTRUCTION TEST.

THE ARMY HAS SEVERAL EFFORTS UNDERWAY TO IMPROVE ITS OVERALL TRAINING PROGRAM. IT HAS ALREADY BEEN DECIDED THAT IN THE FUTURE MORE OF THE TRAINING WILL BE DONE THROUGH TRAINING PROGRAMS AT THE UNIT OR INDIVIDUAL LEVEL.

THE ARMY ALSO HAS UNDERWAY SEVERAL EFFORTS TO DEVELOP AND FIELD COMPUTERIZED TACTICAL DATA PROCESSING SYSTEMS. ONE SUCH COMPUTERIZED SYSTEM - CALLED DEVTOS IS LOCATED IN THE COMPOUND TO THE REAR OF THIS PORTACAMP. IT SEEMS LIKELY THAT WHEN SUCH SYSTEMS ARE NOT BEING USED TO SUPPORT TACTICAL OPERATIONS THEY COULD BE USED TO PROVIDE UNIT AND INDIVIDUAL TRAINING PROGRAMS. ONE OF THE OBJECTIVES OF THIS PROJECT IS TO CHECK OUT THIS IDEA OF USING TACTICAL COMPUTERS FOR INDIVIDUAL TRAINING.

THE PROJECT HAS SEVERAL OBJECTIVES. IN ORDER TO MEET THESE OBJECTIVES YOU WILL BE DIVIDED LATER ON INTO THREE GROUPS. THE FIRST GROUP WILL HELP US OBTAIN INFORMATION ABOUT HOW WELL THE STANDARD METHOD OF INSTRUCTION GETS THE MATERIAL ACROSS TO THE STUDENT. THE SECOND GROUP WILL HELP US DETERMINE IF TACTICAL DATA PROCESSING EQUIPMENT CAN BE USED TO GET THE SAME INFORMATION ACROSS. THE THIRD GROUP WILL LEARN A NEW TYPE OF CODE AND OPERATE A NEW DATA INPUT DEVICE. THIS DEVICE IS DESIGNED TO PERMIT YOU (FOR EXAMPLE, WHILE OUT ON PATROL) TO INPUT CRITICAL INFORMATION DIRECTLY INTO COMPUTERS THAT ARE LOCATED SOME DISTANCE AWAY. THE HARDWARE ITSELF HAS BEEN DESIGNED AND CHECKED OUT, BUT WE DON'T HAVE ANY PERFORMANCE DATA. WE WANT TO FIND OUT HOW MUCH TRAINING IS NEEDED FOR PEOPLE TO LEARN TO INPUT BATTLEFIELD MESSAGES IN A TIMELY MANNER AND WITH FEW OR NO ERRORS.

THESE ARE THE OBJECTIVES YOU WILL BE HELPING US TO ACHIEVE DURING THIS STUDY. I WANT TO ASSURE YOU THAT THE DATA WHICH WILL BE COLLECTED WILL BE HELD IN STRICTEST CONFIDENCE. IT WILL NOT BE USED IN ANYWAY TO INFLUENCE YOUR MILITARY CAREER. THE RESULTS WILL BE POOLED AND USED ONLY TO AID THE ARMY IN MAKING FUTURE DESIGN DECISIONS. YOUR COOPERATION AND BEST EFFORT ARE REQUIRED IF MEANINGFUL RESULTS ARE TO COME OUT OF THIS PROJECT.

SHORTLY YOU WILL BE GIVEN SPECIFIC INSTRUCTIONS IN TERMS OF THE PARTICULAR JOB YOU WILL HAVE TO DO. HOWEVER, THERE ARE SOME ADMINISTRATIVE MATTERS I'D LIKE TO MENTION.

FIRST, THE LATRINES - THE PORTABLE YELLOW COLORED VARIETY - ARE LOCATED TWENTY METERS TO THE REAR OF THIS PORTACAMP.

SECOND, IF YOU ARE WORKING IN THE RESTRICTED AREA--THE DEVTOS COMPOUND--CERTAIN AREAS ARE OFF-LIMITS. WHEN YOU ARE ASSIGNED THAT AREA THE FIRST THING YOUR TEST TEAM ESCORT WILL DO WILL BE TO POINTOUT TO YOU THE AREAS INTO WHICH YOU CANNOT GO.

THIRD, A FOOD VENDOR TRUCK COMES INTO THIS AREA BETWEEN 11:00 AND 11:30. WE BREAK FOR LUNCH THEN. LUNCH WILL BE EATEN IN THESE VANS OR OUTSIDE, IF YOU PREFER. THERE ARE MESS HALLS AT MASSTER FOR THOSE WHO MAY HAVE REASON TO WANT TO EAT THERE. IF, FOR EXAMPLE, YOU HAVE A MEAL TICKET. TO MEET THAT REQUIREMENT WE WILL NEED TO ARRANGE FOR TRANSPORTATION. IS THERE ANYONE HERE WHO WANTS TO EAT AT THE MESS HALL RATHER THAN BUY HIS FOOD FROM THE TRUCK.

FINALLY, WE WANT YOU TO KNOW WHAT TO EXPECT. SHORTLY YOU WILL BE GIVEN A TEST ON SOME SUBJECT AREA IMPORTANT TO ARMY ACTIVITIES, IN THIS CASE THE SUBJECT WILL BE MATHEMATICS. WHILE THESE ARE BEING SCORED YOU WILL BE GIVEN A BREAK. COFFEE WILL BE AVAILABLE TO YOU IN PORTACAMP NUMBER 6. AFTER THAT YOU WILL BE ASSIGNED TO ONE OF THE THREE GROUPS I HAVE JUST DESCRIBED. AT THE END OF THE

DAY YOU WILL BE GIVEN ANOTHER TEST....AFTER WHICH YOU WILL BE INTERVIEWED TO GET YOUR REACTIONS....COMMENTS....AND SUGGESTIONS. THEN YOU WILL BOARD THE BUS - AROUND 1600 - 1615 HOURS - AND BE RETURNED TO YOUR UNIT.

BEFORE WE BEGIN THE NEXT STEP IN THIS OPERATION ARE THERE ANY QUESTIONS?

THANK YOU, I SHALL NOW TURN YOU OVER TO SGT. SHAW.

(Page E-2 blank)

APPENDIX E

INSTRUCTIONS FOR THE SELF-STUDY GROUPS

CSW, TACTICS, GED

APPENDIX CONTENTS

This Appendix contains the sets of instructions that were given to subjects assigned to the Self-study Groups for CSW, Tactics and GED. In addition to instructions for GED self-study subjects, adjunct materials were created to parallel the on-line instruction contained in the decimal word problem lesson (DEC4).

INSTRUCTIONS

You are being given a study period to study the LAW.

During this period, please cover the following in regard to the LAW:

1. Characteristics
2. Component Parts
3. Capabilities and Limitations
4. Maintenance and Inspection
5. Preparation for Firing
6. Aiming the LAW and vulnerability of armor
7. Firing positions
8. Malfunctions and immediate action
9. Restore LAW to carrying configuration

The above topics are covered in FM 23-33, paragraphs 1-13, 18-19, 24-29, 34. (See Study Reference Manual, Vol. II, Crew Served Weapons, pages 51-59, 64, 65-79, 80.)

Work at your own pace. Take breaks when you need them.

The monitor will let you know when the period is over.

INSTRUCTIONS

Tactics is one of the subtests on the 11B40 MOS Proficiency Test. You are being given a study period to study tactics.

During this period, please cover the following Tactics subjects:

	Area	Topic
1.	Individual Combat Training	Estimating Distance OPs and LPs
2.	Individual Skills and Knowledge	Characteristics of rifle, automatic rifle and grenade launcher fire. Classes of fire with respect to target and ground.
3.	Squad Combat Formations	Dismounted squad formations and arm and hand signals. Tactical considerations for the dismounted squad formations.
4.	Squad Battle Drill	Fire support and maneuver elements and mission of each. Types of battle drill squad maneuvers and appropriate arm and hand signals. Factors in tactical employment of the squad.

The above topics are covered in:

1. Individual Combat Training:
   FM 21-75, paragraph 13, 14, pages 12-15
   (Study Reference Manual (SRM), Vol. III Combat Techniques and Tactics, paragraphs 13 and 14, pages 139-142.)

2. Individual Skills and Knowledge:
   FM 23-12, Appendix B, paragraphs 19, 20, 21, pages 11-16.
   (SRM, Vol. III, paragraphs 19, 20, 21, pages 332-337.)

3. Squad Combat Formations:
   FM 23-12, Appendix B, paragraphs 1-6, pages 78-89.
   (SRM, Vol. III, pages 371, 373, and 374, figures 53, 54, 61, 63)
   FM 7-10, Appendix D, pages D-1 through D-4.
   (SRM, Vol. III, paragraphs D-1 and D-2, pages 98-101)

4. Squad Battle Drill:
   FM 23-12, paragraphs 29, 30, pages
   (SRM Vol. III, paragraph 29, 30, pages 339, 340 and 341)

   FM 7-10, Appendix E, paragraph E-1 to E-11, pages
   (SRM Vol. III, Appendix E. E-1 through E-9, pages 117 through 122)

   FM 23-12, Appendix D, pages 78-89.
   (SRM Vol. III, pages 371, 373, 374, figures 53, 54, 61, 63)

   FM 7-10, pages D-2 and D-3
   (SRM, Vol. III, paragraphs D-2, pages 99-101)

If you do not have the above references, please raise your hand and the monitor will give them to you.

Work at your own pace. Take breaks when you need them.

The monitor will let you know when the period is over.

GED MATH

PROCEDURES

1. Put your textbook and Study Guide side-by-side and open them to:

Study Guide	Textbook
Lesson 11	Chapter 4
pages 40-42	pages 170-185

Use your bookmark if it helps you with the textbook.

2. Read the Study Guide, page 40, down to "Study Notes", then begin reading pages 170-185 in the Textbook.

3. In the Study Guide there are Study Notes and calculation examples for textbook pages 171, 172, 173 and so forth. After reading a page in the textbook, look for a study note or example in the Study Guide. If there is one, do what the study note says.

4. Now, beginning on page 171 of the textbook and page 40 of the Study Guide . . . .

   a. Topic: Decimal Notation

      Textbook Pages 171-176

      Study Guide Pages 40, 41

   Read the textbook pages. Do the Developmental Exercises, and the Exercises. Read all notes and examples in the Study Guide.

   b. Topic: Operations with Decimal Fractions

      Textbook Pages 177-180 (top)

      Study Guide Page 41

   Read the textbook pages. Do Developmental Exercises and Exercises in textbook. See the example in the Study Guide.

   c. Topic: Expressing Common Fractions in Decimal Form

      Textbook Pages 180-182 (top)

      Study Guide Pages 41, 42

   Do Developmental Exercises and Exercises in textbook. Use the Study Guide notes and examples.

GED MATH

PROCEDURES (CONTINUED)

d. Topic: Rounding Numbers

Textbook Pages 182-185 (mid-page)

Study Guide Page 42 (top)

Read all pages up to "Error and Precision in Measurement". Do Developmental Exercises and Exercises. Refer to the exercise example in Study Guide.

e. Self-Examination Exercises

Study Guide Pages 42, 70-72

Textbook Do all exercises listed in the Study Guide, page 42.

Check your answers using the "key" on pages 70-72 of the Study Guide.

f. Review Exercises

Textbook Page 207 Exercises 1-22

GED ADJUNCT MATERIALS

WORD PROBLEMS

HOW TO SOLVE IT

THE VERY FIRST THING TO DO TOWARD SOLVING A PROBLEM IS TO READ IT VERY CAREFULLY. AFTER YOU'VE READ THE PROBLEM CAREFULLY, SEE IF YOU CAN ANSWER THESE BASIC QUESTIONS:

1. WHAT DOES THE PROBLEM TELL?

SOMETIMES FACTS OR DATA ARE INCLUDED WHICH YOU WILL NOT NEED TO SOLVE THE PROBLEM. WE CALL SUCH UNNECESSARY INFORMATION IRRELEVANT.

EXAMPLE MARY WEIGHED 148 LBS.
SHE WAS MUCH TOO FAT.

HOW MUCH MARY WEIGHS MATTERS; BUT NOT AN OPINION OF HOW FAT SHE WAS. WHILE WE WANT TO CHOOSE WHAT MATTERS, WE WANT ALSO TO IGNORE USELESS OR IRRELEVANT INFORMATION.

2. WHAT DOES THE PROBLEM ASK?

LOOK FOR KEY WORDS IN THE PROBLEM THAT CLUE YOU IN ON WHAT IS WANTED. HERE ARE SOME OF THEM:

THE WORD FIND
FIND THE DISTANCE TRAVELLED.
FIND THE NET AMOUNT MR. RALSON PAID.
FIND THE AVERAGE NUMBER OF POINTS SCORED.

THE WORD WHAT
WHAT IS THE PERCENT INCREASE IN POPULATION?
WHAT IS HIS SCHOOL TAX?

THE WORDS HOW MUCH
HOW MUCH WEIGHT DID HE LOSE?
HOW MUCH WAS THE CARRYING CHARGE ON MR. ANGEL'S TV SET?

THE WORDS HOW MANY
HOW MANY GALLONS OF GAS DOES SHE NEED?
HOW MANY MUST I SELL TO MAKE A PROFIT OF $35?

THE WORDS HOW LONG
HOW LONG WILL IT TAKE HIM TO PAY OFF HIS MORTGAGE?
HOW LONG WILL IT TAKE TO GET THERE?

OR THE WORDS HOW FAR
HOW FAR IS IT FROM CITY A TO CITY B?
HOW FAR DID THE PLANE FLY?

(Page E-12 blank)

WHEN YOU KNOW WHAT IS GIVEN AND WHAT YOU'RE LOOKING FOR THEN YOU'RE READY TO FIGURE OUT HOW YOU CAN USE WHAT YOU KNOW TO FIND THE ANSWER. SO THE THIRD QUESTION TO ASK YOURSELF IS:

3. HOW TO SOLVE IT?

HOW CAN I USE WHAT I KNOW TO FIND THE ANSWER?

OFTEN IT IS VERY HELPFUL TO DECIDE WHAT OPERATION IS CALLED FOR.

ADD?	SUBTRACT?	MULTIPLY?	DIVIDE?
9 +3 12	9.68 -5.31 4.37	3.50 x .02 .0700	11.3 13)146.9 13 16 13 39 39

ON THE FOLLOWING PAGES ARE THREE EXAMPLES OF HOW TO SOLVE WORD PROBLEMS.

(Page F-2 blank)

APPENDIX F

INSTRUCTIONS FOR THE ALPHA DOT CODE STUDY

APPENDIX CONTENTS

This Appendix contains the instructions and sample worksheets for the Alpha Dot Code study. Subjects of MASSTER Test 122 assigned to the Control Group served as subjects for this unrelated project.

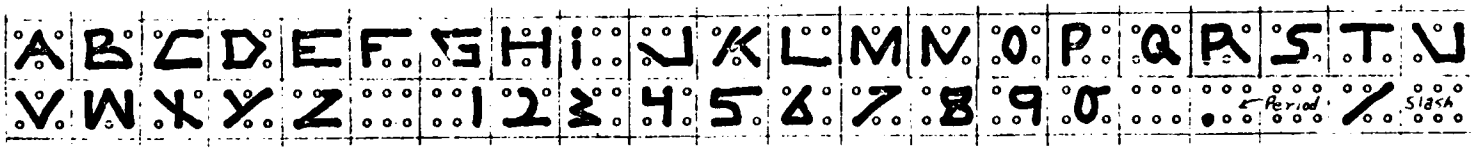
NAME_____

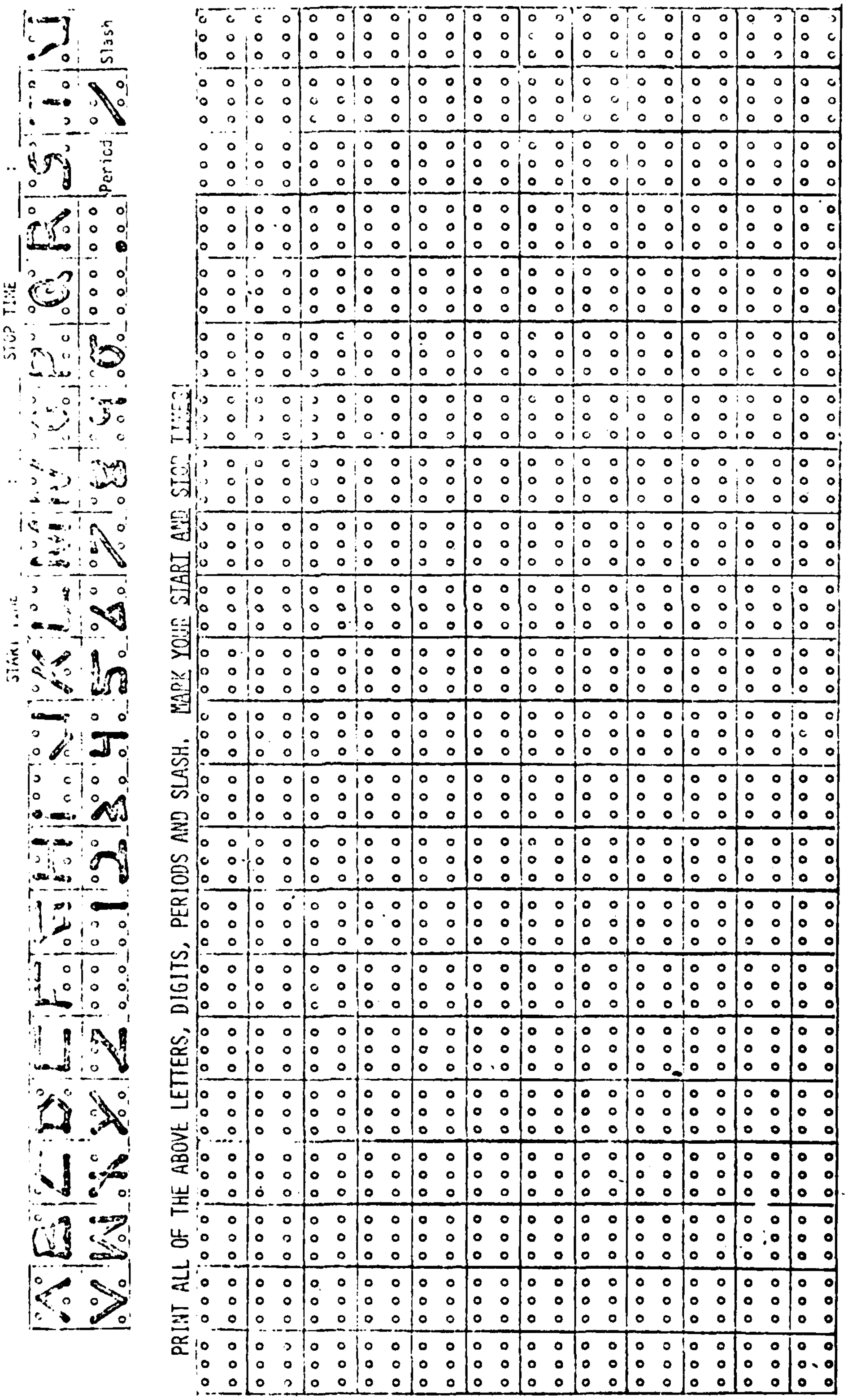
DATE_____

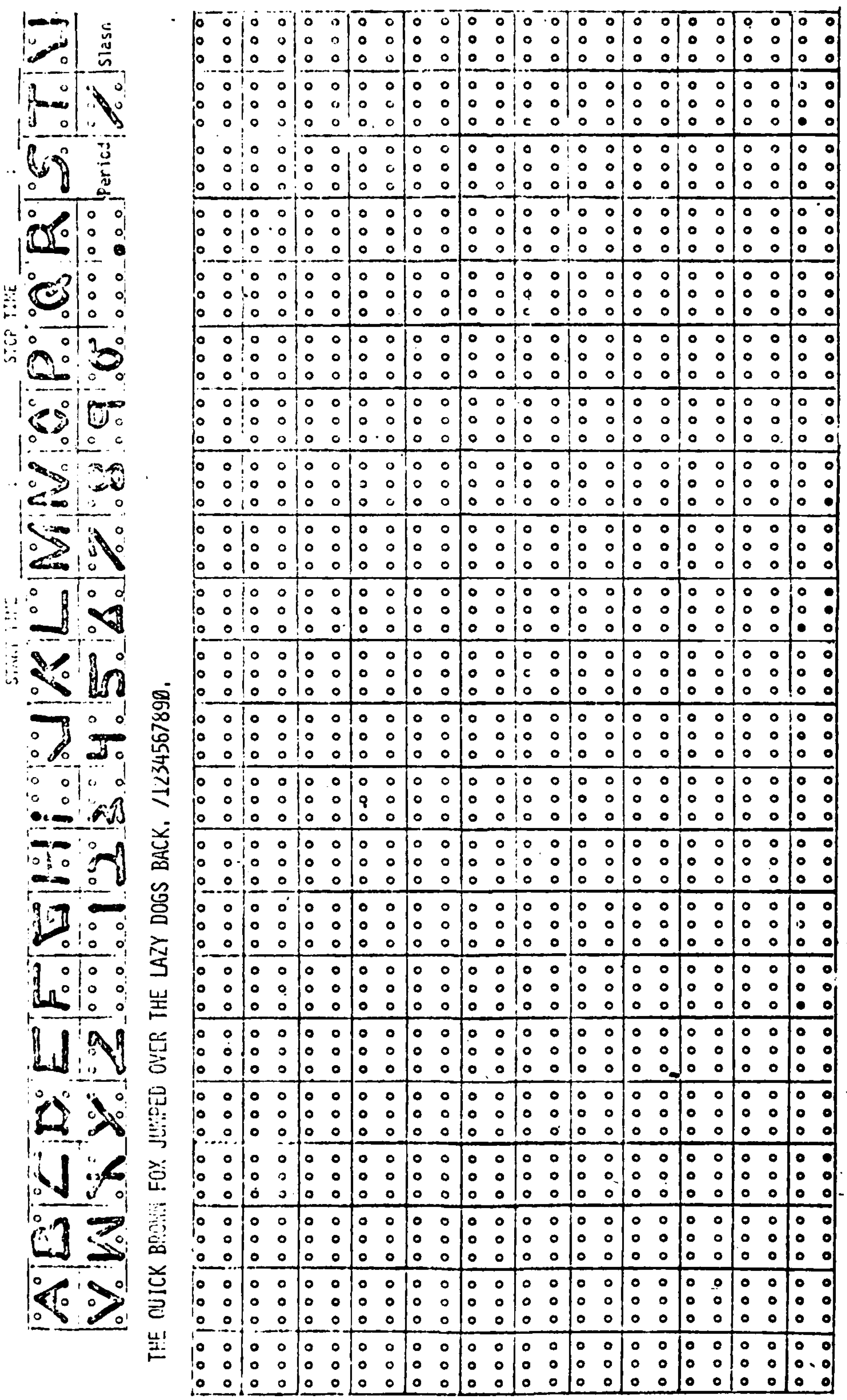
The purpose of this project is to get data about a new type of code. The code is shown below.

This code is designed to make it possible for people to input messages directly into a computer. The code uses a character set of letters and numbers that are printed in a special way so that each character touches a different combination of the 6 dots. Your job is to learn to print the letters and number so that each character touches only the proper dots.

The following sheets contain practice messages. At the top of each sheet is an example of the character set. You are to try to learn the complete character set as quickly as possible. Later you will be asked to write messages without seeing the character set so try to memorize the special shape of each letter and number as quickly as you can.




START TIME
STOP TIME
Period
Slash
PRINT ALL OF THE ABOVE LETTERS, DIGITS, PERIODS AND SLASH. MARK YOUR START AND STOP TIMES!


ABCDEFGHIJKLMNOPQRSTU
VWXYZ1234567890./
START TIME
STOP TIME
Period
Slash
THE QUICK BROWN FOX JUMPED OVER THE LAZY DOGS BACK. /1234567890.

APPENDIX G

AI DEBRIEFING QUESTIONNAIRE

CAI GED DEBRIEFING QUESTIONS

NAME AND GRADE _____ SSAN _____

UNIT _____ SUBJECT STUDIED _____

INTERVIEWER _____

(Var. No.)

(57) 1. What did you think of the computer-assisted learning situation that you went through today?

2 = positive *0 = negative*

1 = neutral

(58) 1b. My attitude toward the CAI was that I . . .

(1) disliked it very much

(2) disliked it

(3) neither liked nor disliked it

(4) liked it

(5) liked it very much

(59) 2. Instructions for using the equipment were . . .

(1) very difficult to understand

(2) difficult to understand

(3) borderline

(4) easy to understand

(5) very easy to understand

(60) 3. Did you have any problems or difficulties in using the equipment or interacting with the computer?

(1) yes (2) no If yes, please describe them.

_____

_____

(Var. No.)

4a. Do you have problems with:

(102) (A) Addition (1) Yes (2) No

(103) (B) Subtraction (1) Yes (2) No

(104) (C) Multiplication (1) Yes (2) No

(105) (D) Division (1) Yes (2) No

4b. Were any of the words shown to you today on the CRT display hard to understand? If yes, which ones?

_____

_____

(106) 4c. Do you have problems in reading? (1) Yes (2) No

Comment: _____

_____

(61) 5. I estimate that I understood _____% of the instructional material (lesson content) presented.

(62) 6. I estimate the number of incorrect responses I made to questions about the lesson content was _____#.

7. Rank the following factors as causes of your incorrect responses.

	Rank	Factor
(63)	_____	Didn't know the correct answer
(64)	_____	Didn't know how to input the correct answer
(65)	_____	Slips of the fingers; i.e., typos
(66)	_____	Didn't pay enough attention

8a. Describe any part of the lesson content that was particularly good, and tell why.

_____

_____

(Var. No.) 8b. Describe any part of the lesson content that was particularly bad, and tell why.

_____

_____

(67) 9. I think that this method of instruction/learning is. . .

(5) very effective

(4) effective

(3) borderline

(2) ineffective

(1) very ineffective

(68) 10. For satisfactory understanding of the subject being studied, the amount of time provided was:

(1) much too long

(3) fairly long

(5) about right

(4) fairly small

(2) much too small

(70) 12. The technical detail provided was:

(5) very satisfactory

(4) satisfactory

(3) borderline

(2) unsatisfactory

(1) very unsatisfactory

(Var. No.)

(71) 13. The organization of the material presented was:

(5) very satisfactory

(4) satisfactory

(3) borderline

(2) unsatisfactory

(1) very unsatisfactory

(72) 14. My understanding of the material presented was:

(5) very satisfactory

(4) satisfactory

(3) borderline

(2) unsatisfactory

(1) very unsatisfactory

15. - - - omitted - - -

16. - - - omitted - - -

17. - - - omitted - - -

18. - - - omitted - - -

(77) 19. If you were to take a GED test on decimals in the near future, would your test score be significantly improved by your study today?

(3) yes (1) no (2) don't know

(107) 20. How would you compare this computer method of instruction against classroom instruction on the same subject?

(3) computer method is more effective

(1) classroom method is more effective

(2) the two methods are about equal

Why?_____

_____

_____

(Var. No.)

(79) 21. How would you compare this computer method of instruction against self-study using textbooks?

(1) self-study is more effective

(3) computer method is more effective

(2) the two methods are about equal

Why?_____

_____

_____

22. Describe any problems connected with self-study textbooks for your GED Math test.

_____

_____

23. - - - omitted - - -

24. - - - omitted - - -

(82) 25. Should computer courses like these covering the GED subjects be made available to Army personnel?

(3) yes (1) no (2) undecided

Comment:_____

_____

_____

(83) 26a. Suppose that the Army set-up a computer learning facility in your battalion area. Would you voluntarily go there to take CAI in preparation for a GED test?

(3) yes (1) no (2) undecided

26b. - - - omitted - - -

(85) 26c. If yes to 26a or to 26b, what time of day would you prefer for the CAI to be available?

(4) during duty hours (1) during off-duty hours
(3) during both on and off duty hours
(2) don't know

(Var. No.)

(86) 27. Should CAI study be mandatory or voluntary for all people taking GED?

(3) mandatory

(1) voluntary

(2) some combination

Why?_____

_____

_____

28. - - - omitted - - -

29. - - - omitted - - -

30. - - - omitted - - -

31a. - - - omitted - - -

31b. - - - omitted - - -

(91) 32. Have you ever had experience using a computer before?

(2) yes (1) no

(92) 33. If yes to 32, have you ever taken a CAI course before?

(2) yes (1) no

(93) 34. Have you ever heard of CAI before (e.g., in TV, magazines, etc.)?

(2) yes (1) no

(94) 35a. Do you think new things like this would make Army instruction better?

(2) yes (1) no

(95) 35b. Do you think new things like this would make Army instruction more interesting?

(2) yes (1) no

(96) 36. What have you heard about this project before coming over here?

0 = No previous information

1 = Some previous information

_____

(Page G-10 Blank)

EXPERIENCE

(Var. No.)

(98) 1. Total time in military _____

(97) 2. Total time in infantry _____

3. Time at Fort Hood _____

4. Have you had:

a. M72a2 LAW

(1) Years/months_____ (2) MOS_____

(3) Location_____ (4) Job Title_____

(5) What did you do and how many months for each job?

_____

_____

b. Rifle Squad Tactics Experience

(1) Years/months_____ (2) MOS_____

(3) Location_____ (4) Job Title _____

(5) What did you do and how many months for each job?

_____

_____

(99) 5. What is your ETS (Expiration of Term of Service) date?_____

(100) 6. Are you due for transfer from Fort Hood within the next three months?

(1) Yes (2) No Date (If yes) *Var. T01*

(Page H-2 Blank)

APPENDIX H

COMMENTS OF AI SUBJECTS

1. Can go back and understand. Can't do as well with a book.
2. Liked it better than anything I have ever had. Have to pay attention.
3. Computer--have teacher talk with you.
4. Liked it. Learned a lot. Go at own pace.
5. All right if you are smart. Could not get hang of it. Rather have old-fashioned teacher. Had addition and subtraction (in school), no multiplication or division.
6. Learn more than in classes--doing something.
7. Fine--but out of school too long to catch on. Need combined method--classroom first, then computer. Otherwise boring. Better if somebody there to help.
8. No typing experience, no problem after you get used to it.
9. Like it, get more out of it. People do not realize how good it (AI) is.
10. Amazing. (On leave today. Didn't like coming over. Liked it after I got here.) Understand computer better than books. More interesting in front of computer. Got more.
11. Encouragement computer fed to me. Personal touch. Forty or fifty guys in class, went to sleep.
12. Computer is a lot better, quieter, if you want to learn it, you put it into your mind.
13. Surprised all that I learned today on decimals. Got in pretty deep. Know a lot more now.
14. Like computer. Easy to learn from it. Take my time, not rushing. Told you when you made a mistake. Learned more than I thought I would. Can't get into reading books. Computer more compact, gets to the point. Computer is quicker, faster way of learning.

15. Computer would help lot of people get better scores on GED.

16. Learned more in 1 day than 3 or 5 days with a teacher. Tells you what you did wrong. Makes you work for it. Computer holds your interest, leads you in correct way.